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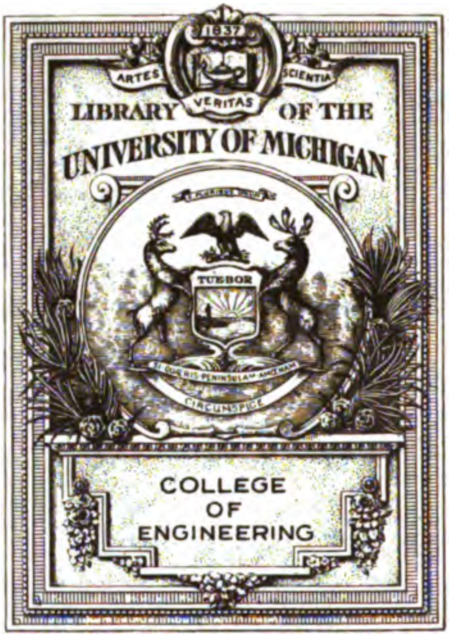

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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of about 1 000 men. Its membership is divided into two principal classes, viz.: Members and Associates. Members are divided into two classes, viz.: Resident and Non-Resident, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The Initiation fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are FOUR dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for Associate membership is TEN dollars, and the annual dues TWENTY dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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New England Water Works Association.

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This Association, as a body, is not responsible for the statements or opinions of any of its members.

RATE REVISION IN MUNICIPAL WORKS.

BY BERTRAM BREWER.

[*Read at Convention, September, 1917.*]

Those in charge of the business of supplying a community with water are certain to receive frequent queries (perhaps complaints is not too strong a word) from the consumers about both the quality of the water and its cost to them. All inquiries of whatever nature ought always to receive proper attention, but the question of rates especially is deserving of periodical attention. It is another of those hardy perennials, and, like the famous Hartford rose garden at Elizabeth Park, requires frequent investigation and study.

It is a pity that some body of scientific men could not devise a schedule of water rates which in principle at least would apply to all communities making a business of supplying themselves with water. As things stand, however, nearly every works has its own traditions and its own peculiar history, both of which limit the scope of any revision to certain limits.

It goes without saying that every water board or superintendent of water works should be thoroughly well informed as to all the fundamental facts of his system having a bearing on the rates. It is often wise to publish a report of the facts concerning this question for the benefit of consumers, and it is always wise to keep ahead of public discussion of rates and keep the public well informed from time to time of conditions and facts which bear on the subject, so as to guide it if possible toward a sound judgment. A printed report of a study of the rate question was published by the writer in 1915 for the Waltham Water Department, and this outline is offered to show a method of treating the problem in municipal works, with the hope that it may be of use to some one. We also have attempted some general observations in the light of our study and after the experience subsequent to the preparation of the 1915 report.

RATE FIXING IN WALTHAM, MASS.

It was decided at the outset that the period to be forecasted should take in the succeeding five years. The Waltham case was much simplified by the fact that the works are not only municipally owned, but that the city has, fortunately, in the main lived up to the principle that its water works are held by it in trust for the people, and has therefore given the water takers the benefit of any surplus of receipts over expenditures by reducing the cost of water from time to time to those who pay for and use it.

The use of city water for public purposes had for several years been cared for by a charge for all public use of water, except drinking fountains and watering troughs, together with a levy of the nominal sum of five dollars annually for each public hydrant. Supplies for private hydrants and for fire protection purposes have always been furnished free, the owner paying the entire cost of installation. The question of the fairness of this deal from a financial point of view was not considered in the 1915 investigation. It had proved satisfactory to all parties for several years, and the fact that the department has never paid taxes to the city pretty nearly evened up the obligation. With this phase of the question eliminated, and granted that the consumers ought to receive the full benefit of their coöperative venture, the investigation which covered the five years succeeding 1915, and as many preceding years as was necessary to help in forecasting the future, was begun along the following lines:

1. A complete estimate of the reproduction cost of the entire system was made.
2. Figures were prepared to show in detail all expenditures for the preceding five years, classified and tabulated so as to show their relation to future expenditures. A chart was prepared show-

ing the growth of population in Waltham. Other charts were made showing the quantity and quality of the water from year to year for a long period. The Waltham supply is a ground water taken from two large wells near the Charles River.

3. The effect of metering on revenue and consumption was also *especially* studied for the preceding five-year period, as this was a very uncertain element in any estimate of future revenue. Up to 1915 less than forty per cent. of the services were metered.

With all these facts fully investigated and at hand, certain assumptions for the future were made. For one thing, it was assumed that metering would be rapidly continued so as to be entirely completed at the end of the five-year period under consideration, and again that such metering would result in some reduction in the per capita consumption. In 1913 the consumption was 90 gal. per person, with 25 per cent. metered, while in 1916 it was 71, with 53 per cent. metered. We believe that this figure should certainly be cut to 65 by the end of the next five years.

The next step consisted in forecasting probable future expenditures, both ordinary and extraordinary. In Waltham these consisted of the following:

1. Installation of and repairs to services.
2. Operating expenses, pumping, care of real estate, reservoirs, mains, gates, hydrants, etc.
3. Fixed charges.
4. Extension of metered services.
5. Replacement of mains.
6. Higher service for the higher parts of the city.
7. Additions to the collecting works to provide for a larger supply.
8. Extension of mains.

In order to ascertain how much profit or loss the next five years would bring, a careful estimate of income on the basis of existing rates was made. Investigation of past experience seemed to indicate that the income from metered services averaged 90 per cent. of what it had been under fixture rates, and this percentage was used as a basis for estimating that portion of the income as the fixture rate services should be changed over to metered. The remainder of the estimate was comparatively simple.

The estimate of income consisted of the following items:

1. Income from fixture rate services.
2. Income from existing metered services.
3. Income from existing fixture rate services changed over to metered.
4. Income from new services.
5. Income from a new high-level supply.
6. Income from installation of services, repairs, etc.

Perhaps it would make it clearer to insert at this point the table just as it appeared in the Waltham report, illustrating the results of this particular study as it was expressed in figures for the Waltham City Government.

ESTIMATE OF TOTAL OPERATING EXPENSES, INCLUDING FIXED CHARGES FOR YEARS 1916 TO 1920.

	1916.	1917.	1918.	1919.	1920.
Ordinary operating expenses...	$38 000	$38 500	$39 500	$41 500	$42 000
Meter installations............	6 000	6 000	6 000	6 000	6 000
Renewals to improve circulation,	2 000	2 000	2 000	2 000	2 000
Extension for high service (fixed charges on $5 0000, 30-year loan)....................				5 000	4 880
Additional supply (fixed charges on $21 000, 5-year loan).....	5 840	4 640	4 480	4 320	4 160
Installation of services and repairs.....................	5 560	5 651	5 742	5 833	5 924
Fixed charges on existing debt..	24 505	23 795	21 795	13 407	10 362
Fixed charges on an expenditure of $8 000 annually for extending street mains............		2 320	4 560	6 720	7 800
	$81 905	$82 906	$84 077	$84 780	$83 126
Contingencies, 5 per cent.......	4 095	4 145	4 204	4 239	4 156
	$86 000	$87 051	$88 281	$89 019	$87 282

ESTIMATE OF INCOME FOR YEARS 1916 TO 1920.

	1916.	1917.	1918.	1919.	1920.
Fixture rate services..........	$38 220	$28 666	$19 111	$9 555	
Present metered service.......	42 410	42 410	42 410	42 410	$42 410
Present fixture rate services changed to metered, incl. rental....................	8 585	17 170	25 755	34 340	42 925
New services (metered, including rental)...................	1 909	3 818	5 726	7 635	9 544
High level supply, new services,				400	450
Installation of services, repairs, etc.......................	2 873	2 919	2 966	3 012	3 058
	$93 997	$94 983	$95 968	$97 352	$98 387

EXCESS OF ESTIMATED INCOME OVER EXPENSES.

1916.	1917.	1918.	1919.	1920.
$7 997	$7 932	$7 687	$8 333	$11 105

It will be observed that the estimate showed a surplus of income over expenses. Definite recommendations were accordingly made, looking to a small reduction in income. The reductions were intended to apply to certain charges which the water takers found most annoying, as, for instance, an annual charge of 10 per cent. of the cost for the meter and its installation in every case. It was also recommended that the city assume the duty of installing supplementary meters in multi-tenement houses, if the owner would arrange the piping so that all meters could be set near together in one cellar.

The report was not published until 1916, and its recommendations were not carried out until the year was half gone, so their effect was not very apparent up to the end of the financial year 1916. Work on the extension of the supply has not yet been begun. It proved to be a bigger problem than was anticipated, and may cost a large amount of money. All this, together with a large saving in operating expenses, due to a new and businesslike administration of affairs, rather upset the estimates, and the department had a larger surplus than was anticipated on January 31 of this year. Just as soon as a definite policy in regard to a more adequate supply can be adopted, it is intended to apply the elements of the 1915 study to the new conditions and adjust prices accordingly.

Summary and Conclusions.

The question may be asked as to why an estimate of reproduction cost was made in this case, where it was not used in fixing the rates. The answer is that the reproduction cost was a sort of taking account of stock. The city auditor has always carried a statement of the book value of the works on his books from year to year, and it was considered wise to check that up with actual figures of values. There is no better way of ascertaining the correct location of fixtures, exposing the weak spots in office and field organization and obtaining an intelligent and comprehensive knowledge of the business. There are at present no obsolescent fixtures, and depreciation was practically cared for in the estimate of the expenditures for the next five years in several of the items. Further on, the writer has something to say regarding payment of taxes by a municipal business venture such as that of supplying water. If taxes are paid, the reproduction cost of value of the works becomes a vital factor.

An enormous amount of literature has been published relative to rate fixing, much of it very complicated and full of perplexities to the average mind, even among men familiar with water-works administration. The problem in a municipal plant is fortunately comparatively simple — mainly to make the returns commensurate with the expenditures.

We attempted to provide for a period of five years. It is a very difficult task to plan so far ahead. The writer knows of one case at least where provision for a fair return is made by giving the water takers an annual discount. The surplus, if there is any, is returned in this way to them each year, while the rates remain unchanged.

While it is a fact that we would, if making a new study of the rates to-day, follow practically the same general course that we did in 1915, it should be stated that subsequent experience and reflection call for some modifications in the program. In the main, however, the methods adopted in Waltham were simple and direct, and in retrospect seem wise. Here is a basis for further revision which can be followed from time to time as conditions change.

The writer believes that it is only fair and logical for the water department to pay taxes on its property, and also that the city should be charged a fair rate for what water it uses as well as for hydrant service. As a basis, therefore, for rate fixing, he would charge a fair price for everything furnished the city and, in return, hold the water department to a strict accounting for all it receives. He would not, however, provide for a franchise tax. If it had received but $50 per hydrant, the Waltham Water Department could have paid taxes on the value of its plant, and in 1916 would have made a further profit to the department of more than $3 000 on the deal.

Where the works have been paid for and maintained by the consumers, the evil practice of taking water-works earnings for general municipal expenses should be stopped. There should be laws to prevent an improvident city government from using the water taker's money to keep down the tax rate, and so pull some politician's "chestnuts out of the fire." This has been done altogether too often. If municipalities in this country, as now seems probable, are to embark more and more in business enterprises, it is highly important that the use of surplus funds should be well safeguarded.

The great advantage of an attempt to inform the public is, of course, to make clear to all the necessity of looking ahead. Without a careful foresight as to the expenditures which are sure to be required, as well as the probable additional demands, there is always danger that the public may call for the distribution of any surplus which may temporarily accumulate. It is not necessary to emphasize the difficulty in increasing rates to cover a shortage as contrasted with the ease of a reduction. Arguments in favor of a reduction in rates always meet with a favorable reception, and they can be answered the more effectively the more widely the real facts are disseminated. Frequently they are advanced by parties who ought to be fully posted, but who, for reasons of their own, prefer to cater to popular sentiment rather than to use their influence to the real advantages of the public, and appeals such as this cannot be ignored or overlooked with safety. They can only be offset by a painstaking exposition of the true situation.

One of the most effective of the arguments which are advanced is based upon the feeling that the poor ought to get things as cheaply if not more cheaply than the rich. In Waltham this has gone so far that an ex-mayor is actually advocating in the public prints a rate of one and one-quarter mills per cubic foot for a minimum annual consumption of 4 000 cu. ft., and a rate of one and one-half mills per cu. ft. for a consumption anywhere between this 4 000 and the point where the wholesale rate begins to apply, this in place of the existing rates of two mills and one and one-tenth mills for domestic and wholesale consumption, respectively. This is quite antipodal to the famous Vanderbilt policy, and serves to emphasize the fact that the idea that those who have money must pay the way for those who have little or none is very popular to-day, and that, whatever we may think of it, it has got to be reckoned with.

We sympathize with the industrious poor man, who is raising a family of children or who has raised such a family, many of whom are just now offering their lives to the country. We believe that such men will have more to say about these matters in the future than in the past. We should surely like to have them get their part of the water supply at cost. We sympathize also with the great middle class which seldom complains, does most of the real thinking in the world, and is subjected to a constant grinding between the " upper and nether millstone."

The wholesale user now gets the low price in Waltham and in most other places. He also gets the free fire service. Perhaps this is right to a certain extent, but we must bear in mind that the poor man is becoming fully as important an element in Democracy as his richer brother. It is well, therefore, in America and in these times, for the management to consider this element in municipal service. It is no use to be officially blind to the signs of the times.

The question of relative rates for different services is, however, only a part, though an important part, of the problem. The main question is rather the necessary amount to be charged upon consumers in order to cover cost. This question, the writer maintains, can be solved satisfactorily only by careful study of future developments, based upon the lessons of the past. There is no panacea for all the difficulties of rate fixing, but the ideal for which we must strive, namely, a square deal and equal privileges for all, can only be reached when we have acquired sufficient wisdom from experience to decide how long to rest upon established order and when to cut loose and go ahead.

DISCUSSION.

MR. HAROLD K. BARROWS. It is not quite clear to me whether the valuation was based entirely on reproduction cost alone. That is, whether or not Mr. Brewer took into account the element of depreciation in getting at his fixed charges.

MR. BREWER. The reproduction cost was figured on the basis of average prices for materials and labor. It was not used at all as a guide in forecasting future expenditures. In the estimate of future expenses provision was made for renewals, care of the debt, and a considerable item for contingencies was added.

CONTROL OF MICROSCOPIC ORGANISMS IN WATER SUPPLIES.

BY WM. HAINE.

[*Read September 12, 1917.*]

The purpose of this paper is to present a brief, non-technical discussion of the relation of " Microscopic Organisms " to water-supply troubles, more especially to those of New England, and to offer some suggestions that may be of assistance to the water-works man.

Without going into a detailed study of the problem, it may be said that all surface water supplies are more or less susceptible to growths of microscopic organisms, but the optimum conditions for their development are to be found in lakes and reservoirs rather than in running streams. Many New England cities are dependent upon impounding reservoirs for their water supply; and there are few municipalities so situated that have not suffered from the effects of microscopic life. The chief difficulties arising from the presence of these organisms are the tastes and odors which they impart to the water. In order to prevent these tastes and odors, many remedies have been suggested and tried, but prior to the use of copper sulphate none had given general satisfaction. By covering filtered water reservoirs, algæ troubles have been eliminated in the case of filtration plants. This method, however, cannot be used for large reservoirs.

In the control of vegetable growths, the only practical method which has been developed as a result of a study of the problem is the copper sulphate treatment, which was ably described by Dr. George T. Moore and Karl F. Kellerman, of the U. S. Department of Agriculture, in 1904. To Dr. Moore belongs the credit of successfully demonstrating, in 1901, the use of the method in the treatment of watercress beds to eliminate objectionable growths of Spirogyra. The first water supply so treated was the reservoir of the Winchester Water Company, Winchester, Ky., which was contaminated with Anabæna,. and the results were very satisfactory. The treatment is now recognized as a standard procedure in water-works operation, and is simple, consisting essentially of placing weighted quantities of copper sulphate in loosely woven bags and dragging them from the stern of a motorboat. This is preferable to a rowboat, since the movement of the propeller assists materially in spreading the chemical evenly over the surface of the water.

While the services of a technically trained man are not necessarily required for this phase of the work, it is essential that some judgment be used in determining the rate of solution from the bags and controlling the amounts of chemical dissolved in the various parts of the reservoir, in order to get the best distribution. It has been the writer's experience that better results are obtained if slightly larger quantities of the chemical are added to the shallow areas, as the heaviest growths are most frequently found in these localities.

As the amount of chemical required for successful treatment of a supply depends in a large measure upon the types of organisms present, it is necessary to know what types we are dealing with, since some of them are more susceptible to the action of copper sulphate than others. We have found that most uniformly successful results are obtained when the amount of chemical is determined on the basis of the most resistant types of odor-producing organisms in the supply. If the dosage is insufficient to kill the more resistant forms, secondary growths develop which also produce trouble. Scientific studies of the amount of copper sulphate necessary for killing various organisms may be found in the literature on this subject, and the results of practical treatment coincide very closely with the figures thus recorded.

In this connection, the most common mistake of the water-works man is to defer action until the growths have developed to such an extent that the consumers object. The treatment produces best results when used as a preventive measure rather than as a cure, therefore it is highly advisable to treat promptly at the first sign of a decided increase of odor-producing algæ. This information can be obtained only by microscopic examinations made at regular intervals, especially during the time when trouble is to be expected. In this way, the odor-producing organisms are detected at their first appearance, and prompt treatment destroys them before the consumers are aware of any possible difficulty. Although the method is undoubtedly efficient under proper control, it cannot be emphasized too strongly that a definite knowledge of the condition of the reservoir is always required, if uniformly successful results are to be obtained.

In some instances, subsequent to the treatment of a supply, large numbers of fish have died, and for this reason numerous researches have been carried out to determine the tolerance of various types of fish to copper sulphate. It has been shown that trout can be killed with .14 parts per million of copper sulphate, while black bass are able to withstand up to 2.10 parts per million, and other species range between these limits.

A phase of the problem that has not been emphasized, however, is the effect of the reduction of the dissolved oxygen in the water following copper sulphate treatment. Laboratory tests of water after treatment show a material reduction in the numbers and types of algæ with rapid increases in the numbers of bacteria, and accompanying these changes the dissolved oxygen in the water is very materially reduced. This change is due to the bacterial activity involving the oxidation of decomposing algæ growths.

Our records, covering a great many copper sulphate treatments, show that there has been no destruction of fish life in the cases where the treatment was given before the growths had developed to any great extent. In many cases the amount of copper sulphate used was greater than that given in the literature as sufficient to kill certain types of fish which were present.

There are numerous records to show that great numbers of fish have been killed as a result of the sudden reduction of the dissolved oxygen content of reservoirs and lakes, following the destruction of heavy growths of algæ by marked changes in weather conditions. This trouble was experienced by one of our Connecticut cities during May of this year, and twelve barrels of fish were taken from the supply. Another instance was reported in Flushing, N. Y., where two hundred carp and a number of perch were killed in Lake Kissena. Sensational reports were circulated to the effect that the fish had been poisoned, but an investigation conducted by a chemist of the New York Water Department brought out the fact that the death of the fish was due, not to any poisonous foreign substance in the water, but rather to a lack of oxygen. Similar conditions have been reported in Massachusetts, New Jersey, and in other states, where copper sulphate had not been used. In the writer's opinion, many instances where large numbers of fish have been killed following copper sulphate treatment, the difficulty has been due to the sudden destruction of large volumes of vegetable growths rather than to any direct poisonous effects of the chemical.

It has been asserted that anything which would destroy fish would be harmful to man, and there are some who object to the treatment on these grounds. Authorities are agreed, however, that copper sulphate as it is ordinarily applied in ridding supplies of microscopic organisms does not endanger public health. The fact that many cities throughout the country have been getting relief for a number of years by the use of the treatment without any evident adverse effects is a good indication that the method is not a dangerous one and merits the attention of any municipality where objectionable types of algæ exist in the water supply.

DISCUSSION.

MR. W. A. MCKENZIE.[*] I should like to ask the speaker what he means by the size of the reservoir, — whether he means the area or takes into account the depth. And what is the maximum amount of copper sulphate which can be used in a reservoir and permit the water to be used by a town? You stated that up to certain sizes of reservoirs it was practicable to use copper sulphate. I have in mind our own reservoir, which covers some 160 acres, with an average depth of about 30 ft., and a capacity of about one billion and a quarter gallons which we treat with success. In other words, where do you draw the line?

MR. HAINE. I think you misunderstood my statement. I referred, in the case of smaller reservoirs, to the fact that it might be feasible to cover them, whereas we treat any sized body of water with copper sulphate. Regarding the maximum amount of copper sulphate used, as stated in the paper, we base the dose upon the most resistant odor-producing type present, and usually it has not taken over three-tenths of a part per million of copper sulphate to clear up the supply in very good shape. There have been instances, possibly, where we have used slightly more. But ordinarily .2 or .3 of a part per million is the average dose, depending upon the organisms present.

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[*] Superintendent of Water Works and City Engineer, Wallingford, Conn.

MR. FRANK L. FULLER.* I should like to inquire of the speaker whether, if the algæ were entirely removed from any reservoir, you would get a repetition of the growth the next year; and if so, where the algæ would come from.

MR. HAINE. The growth in a reservoir under such conditions would be due to algæ carried into the supply from swamps in the drainage areas during spring freshets and early rains. It is not known definitely just what determines the extent of a growth of algæ in a reservoir. Some years there will be a heavy growth in a reservoir, and then it may run along for ten or twelve years before there is another heavy growth. Although we are not certain just what are the governing conditions in that case, yet warm weather, intermittent rains, flushing swamp growths into the supply, and similar factors have an important bearing on the extent of the reservoir growths. The destruction of algæ in the reservoir, therefore, is only effective for the water then in storage.

MR. FULLER. When the algæ are killed by the chemical, it goes to the bottom, I suppose. And does it not decompose and still make trouble?

MR. HAINE. The increases in numbers of bacteria are, of course, kept at a minimum if copper sulphate treatment is applied before the algæ growths have reached a high state of development, as the numbers of bacteria increase in proportion to the food supplied by the destruction of the algæ.

The copper sulphate exerts a poisonous effect on the algæ so that the organisms are precipitated as dead organic matter and food for bacteria. The bacteria which are always present decompose the dead algæ and multiply in large numbers during the process. These sudden increases in bacterial counts are noticed not only after copper sulphate treatment but also after sudden destruction of algæ growths in the fall, when cold weather adversely affects their development.

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* Civil Engineer, Boston, Mass.

As the bacterial oxidation of the dead algæ reduces the dissolved oxygen in the water, early treatment of the supply tends to eliminate the danger of killing fish as a result of depletion of oxygen in the water.

Mr. Fuller. Does the copper sulphate have any effect upon the bacteria?

Mr. Haine. Copper sulphate has a slight bactericidal action. When used in large enough quantities, it is a germicide. It has been used for sterilizing the water. I have in mind one instance where copper sulphate was used to the extent of one part per million to sterilize the water in place of chlorine gas. But in the proportion used in algæ treatment it has no appreciable bactericidal action.

A Member. I might inquire, in figuring the quantity of water to be treated, if you figure the total capacity of the reservoir, or take 6, 8, 10, or 15 feet on the top. What is your custom?

Mr. Haine. Our custom is to figure the capacity of the reservoir as near as we can estimate it. In treatment, however, we distribute somewhat larger proportions of chemical over the shallow areas where the growths are usually heavy.

A Member. The speaker has suggested that it is better to treat the water as a precautionary measure when the microscopic growth is first observable. All the growth is not algæ, but we hear more about algæ because it is a common growth in our open reservoirs. In our case we use underground water stored in a cement reservoir, and every year we get a growth of Cypris. I should like to ask the speaker's opinion as to whether the best time is to treat the water when the growth is first observable, no matter how minutely, or to wait until the organisms have more fully developed.

Mr. Haine. It is a general principle in the treatment of algæ or microscopic organisms, to treat the supply as soon as the organisms have developed in sufficient numbers so that they might become objectionable. In your case, more permanent results would be obtained by covering the reservoir, as stored ground waters are especially liable to develop heavy growths of algæ.

A MEMBER. Heretofore we have waited until the growth was quite pronounced, although it had not reached an objectionable stage, and then treated it with good results. But I wondered whether, as a precautionary measure, it might be treated as soon as it was observable at all. I had that question rise in my mind a year or two ago, and I didn't want to wait for them to develop.

MR. HAINE. Undoubtedly it would do no harm, and if it would check that growth before it had got practically any start it might save trouble, for there may come a time when you will not check it soon enough.

MR. FULLER. In Wellesley, Mass., we have always had a ground-water supply, and originally it was pumped into an open reservoir, and we were obliged to clean out that reservoir almost every year, and in the bottom we would find a greenish substance which I supposed was the microscopic organisms of sea moss. Those would be removed and the water would be pumped into the reservoir again, and for a few days it would be perfectly clear and you could almost see the bottom — I don't think through the entire depth, which was perhaps twenty feet, but it would be very clear; but in a few days it would become cloudy, and you could only see perhaps through two or three feet of the water, the reason, I suppose, being the start of the growth of microscopic organisms of one kind or another. Now, I don't see where the origin of those organisms came from. They were not in the ground; they did not come with the ground water; they must have come in in some other way, I presume. Yet this reservoir was on a hill, and I never could exactly account for their presence in the water. Later we covered that same reservoir with an arched roof, and now we have no trouble at all, and it is not necessary to clean out the reservoir scarcely ever. If we should draw off the reservoir we find practically nothing on the bottom. I do not exactly see where those organisms came from.

MR. HAINE. It is pretty hard to state where they might have come from, for when you consider the small space occupied by an organism, there could be a great many organisms in the reservoir even after it had had a thorough cleaning, unless there were special means taken to sterilize or kill the organisms. Had you used copper sulphate in a fairly strong solution, and let it stand for some time, and then cleaned out your reservoir, you would probably have eliminated the trouble, for some time at least. There is, of course, the possibility of straw and grass being carried by birds from swamp areas and dropped as they pass over the reservoir. If these particles were wet and coated with microorganisms, it is quite probable that growths would develop in the reservoir.

MR. FULLER. You mean, before we covered it?

MR. HAINE. Yes.

MR. FULLER. I suppose the covering prevented the presence of light, and that prevented their germinating.

MR. HAINE. To almost all microscopic organisms, sunlight is absolutely essential, for by the action of sunlight they take up their food, and if you take away the sunlight they do not develop.

A MEMBER. Is there any means but sulphate of copper to get rid of these organisms?

MR. HAINE. The only practical means that have been discovered are either copper sulphate or protection from sunlight.

A MEMBER. We have used hypochlorite with great success.

MR. HAINE. Hypochlorite has been tried but has not proven satisfactory.

A MEMBER. It is safer, isn't it, than bisulphate of copper which you have to use with greater care? The hypochlorite will assimilate more quickly through the body of water. Now, I am speaking from experience.

MR. HAINE. Yes, I appreciate that. How have you distributed your chloride of lime?

A MEMBER. I went through with a rowboat and distributed it so much to the gallon, through the reservoir, with good results. The people noticed the change in the water.

A MEMBER. The point I wish to bring out is, if you use the bisulphate of copper you will kill the fish, and what will kill the fish will hurt the people.

A MEMBER. I understand that some organisms require five times as much bisulphate of copper as others. I was wondering what organism it did not kill. Cypris is very difficult to destroy.

A MEMBER. It seems to me, to get at the source of this trouble — the drainage areas — would accomplish a great deal and would not require treating nearly as much. In our own case, we had a reservoir of 1 250 000 000 gal. that, previous to clearing up the swamp, cutting the brush, and keeping the brush cut so that our swamp areas were drained out, required about .4 of a pound per million gallons, which is now cut down to between .2 and .2¼ lb. per million gallons. By treating when there is a breeze blowing from one end to the other we get very much better results and accomplish it very quickly. We have never killed any fish, and have run up to .4, and a little over. And another place in New Jersey there is a large lake, where there is trouble with a growth of lily pads and vegetation. Copper sulphate was spread around in these growths and it was found that instead of being obliged to cut that off, the vegetable growth would die, break off at the root at the bottom of the lake and float down the stream. It saved a good deal of hard work, as it was not necessary to cut out the vegetable growth in the shallow area of the pond.

MR. W. C. HAWLEY.* I am a little surprised at the statement that trout will be killed by such a small dose. I have put it in a reservoir containing many trout without killing any of them. I don't think we want to worry very much about the effect of the copper sulphate any one can get out of the water. We get more copper sulphate out of a dish of French peas or beans, where it has been used as coloring matter, than we would get out of a barrel of water.

MR. HAROLD K. BARROWS.† I should like to ask the speaker what his experience has indicated in regard to the effect of drawing down a reservoir, more particularly a natural pond, on the tendency for the algæ growth. What I have particularly in mind is, perhaps, a pond which in dry periods of the year may be drawn down to a considerable extent and the shores exposed in such a way that vegetation is likely to grow for a time. Has his experience indicated that this is likely to result in an increased growth of the algæ?

MR. HAINE. Lowering the water level of your reservoir allows for the growth of vegetation on the exposed bottom, and when this is covered, it produced, during decomposition, food material for the development of algæ carried into the supply from the drainage area.

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* Chief Engineer and General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa.

† Consulting Engineer, Boston.

MR. BARROWS. If I might add just a word, what I had in mind particularly was shallow areas. When these are drawn down to such an extent that a very considerable part of its area is shallow, — is that likely to result in an increased growth of algæ?

MR. HAINE. Yes, for the reason just stated.

MR. FULLER. The supply at Ware, Mass., is very similar to the supply at Wellesley. It is a ground-water supply, and the reservoirs are almost exactly the same size and similarly situated. Now, I think that Ware has never had any trouble at all with any growth of microscopic organisms. They have never covered the reservoir, which was built in 1886, and, although the reservoir has been cleaned from time to time, I think they have never had any such cleanings as we have had at Wellesley. This seems to be an interesting matter because I think in New England, at the present time, there are not many reservoirs containing ground water that are not covered. A great many of them have been covered.

MR. WALTER H. RICHARDS.* Just one thing that has been drawn out here to-night occurs to me. I have watched this thing now ever since they discovered that there was such a thing as algæ, certainly, because I still remember when they told us it came from vegetation. Everybody said so. In fact, they had not discovered these microscopic growths at all. And it occurred to me that until you find out where they come from and what makes them grow, you are working in the dark continually, and it seems to me that the bacteriologists have had most time enough now. They have spent about twenty-five years at it, and it is about time that they told us where they come from, and then we will know ourselves how to get rid of them.

MR. P. J. CONLON.† We are in the highest part of Massachusetts, at North Adams. About five or six years ago the superintendent at Williamstown came to me and said, " Your water was bad last year." I answered, "Yes, it was." He said, "Come over and see what you can do for us," which I did. The water came out of a rock in the mountain. We treated the water without advice of a chemist or any one else, with results very satisfactory to the superintendent at Williamstown. But I didn't tell what I did to it. The method used I had seen described in the *Engineering News*. I gave it the same treatment we have been talking about, — hypochlorite of lime. But that is not surface water; it is from the highest pond in the state of Massachusetts. Now, there you are with your hypochlorite of lime and your bisulphate. I used 8 lb. to the million gallons, and I think the reservoir is clean.

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* Engineer and Superintendent, Water and Sewer Department, New London, Conn.

† Superintendent Water Department, North Adams, Mass.

Our water comes from the surface. The Williamstown water comes from the mountain, right out of the rock, in a 6-in. stream, and it doesn't touch any land at all.

MR. HAINE. If the ground water is stored on the surface, sunlight should be eliminated by covering the reservoir or algæ control is likely to be necessary.

MR. HOMER R. TURNER. I should like to ask in regard to these pond or stagnant waters of lagoons. If it were impossible to drain them, could an alternative method be devised by putting a dike between the reservoir and the stagnant area to prevent the water getting into the reservoir, except by filtration through the dike, which would help in reducing the chance of algæ?

MR. HAINE. Yes, that undoubtedly would assist for a time, but the filter banks are likely to clog. There was a paper read last year before the American Water Works Association by people in charge of water supply at St. Paul, Minnesota, and in that instance they recommended the treatment of small lagoons and small swamp areas with copper sulphate by means of a spray pump.

SOME METHODS AND RESULTS OF FILTRATION AT PROVIDENCE WATER WORKS.

BY FRANK L. CADY.*

[*Read September 13, 1917.*]

The filters of the Providence Water Works are located at Pettaconset, on the Warwick side of the Pawtuxet River, opposite the main pumping station, which is in Cranston.

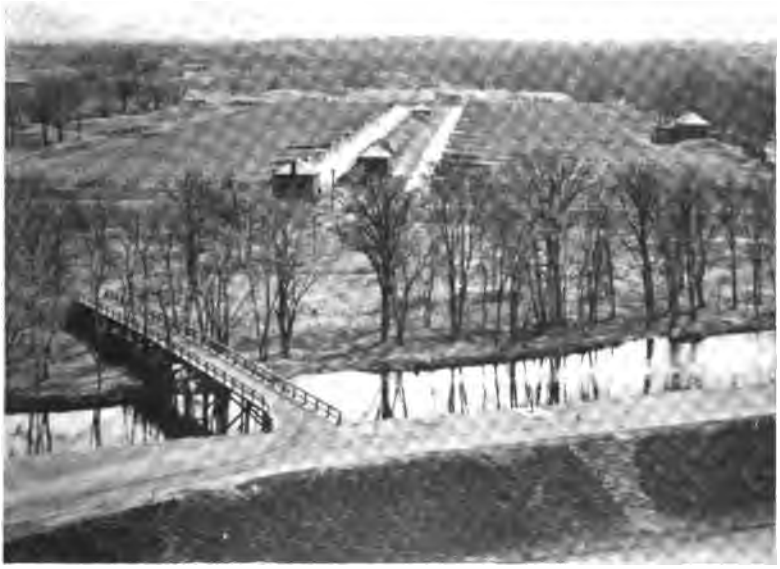

FIG. 1. A GENERAL VIEW OF FILTERS FROM TOWER OF PUMPING STATION.

The supply of water is taken from the Pawtuxet River about four miles above the village of Pawtuxet, which is at the mouth of the river, and about seven miles from the center of Providence. The watershed of the river above Pettaconset contains about one hundred and ninety-six square miles. An estimated population of about 31 000 lives on this watershed, mostly concentrated in seventeen mill villages within nine miles of the filtration plant.

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* Bacteriologist with the City of Providence at the Pettaconset Pumping Station.

The plant in November, 1905, when first put in operation, consisted of six open filters of one acre each, with two more in process of construction. One of these was later put in operation as an open filter. After the first winter, it was decided to cover all beds and to build two more filters, making ten in all, each,

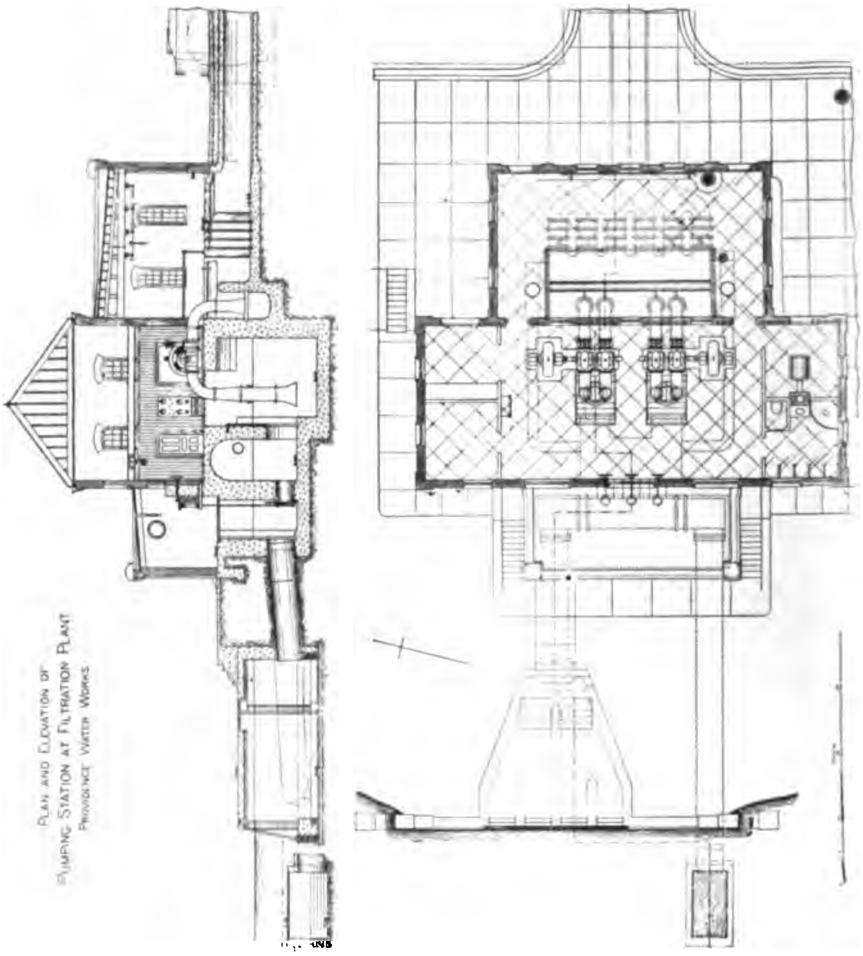


FIG. 2.

when covered, containing .98 acres. The winter of 1906–7 was very severe, and the expense of removing ice from the beds proved the necessity for covers.

The pumping plant, which lifts the water from the river on to the filters, is at the edge of the river, about 1 200 ft. above the old intake at the Pettaconset Pumping Station. The water is lifted by the De Laval centrifugal pumps, driven by direct-connected electric motors, arranged in duplicate, each unit with a capacity of 20 000 000 gal. per day with a 7-ft. lift.

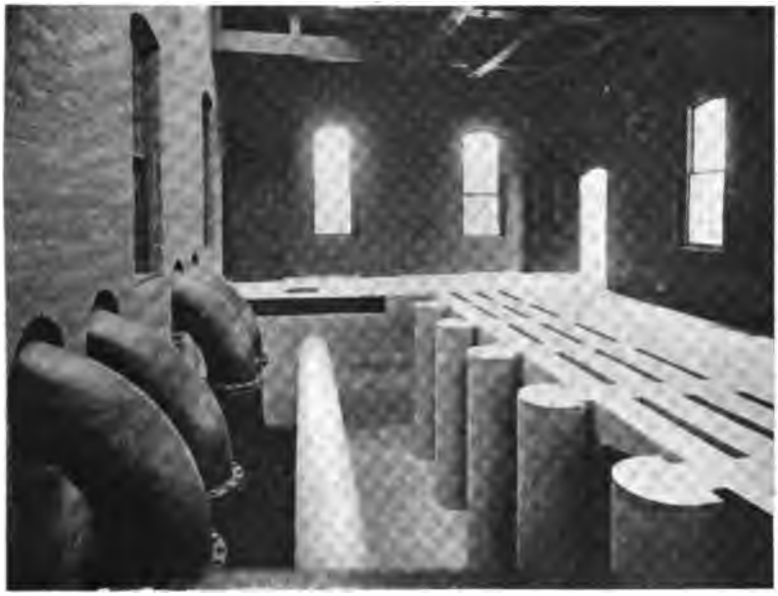
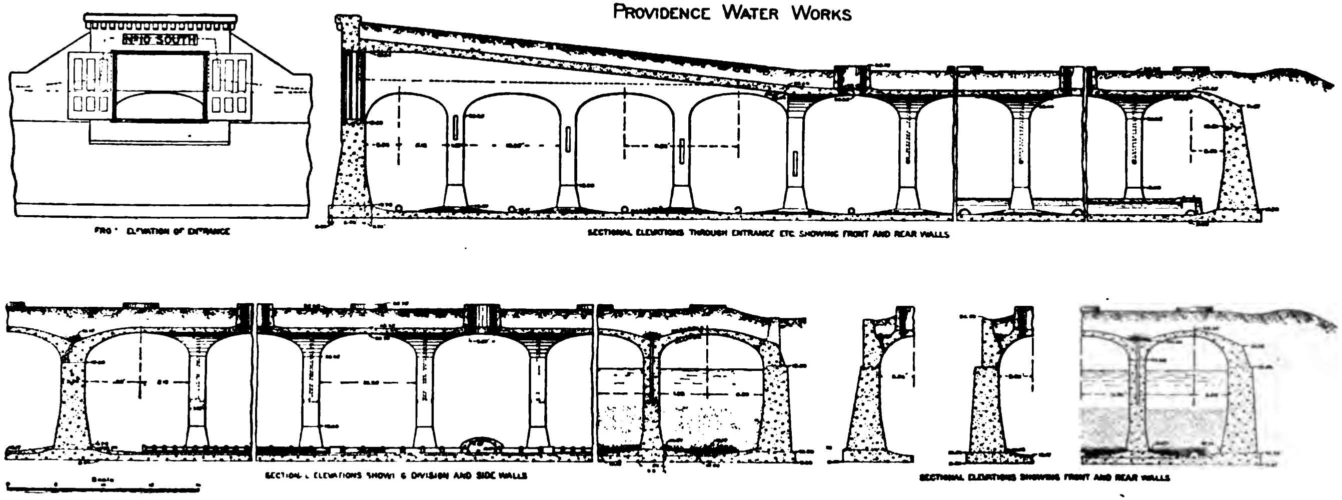


FIG. 3. INTERIOR VIEW OF SCREEN CHAMBER.

There are two intakes; one, a horizontal grating slightly above the bed of the river; the other, a vertical grating at the shore line.

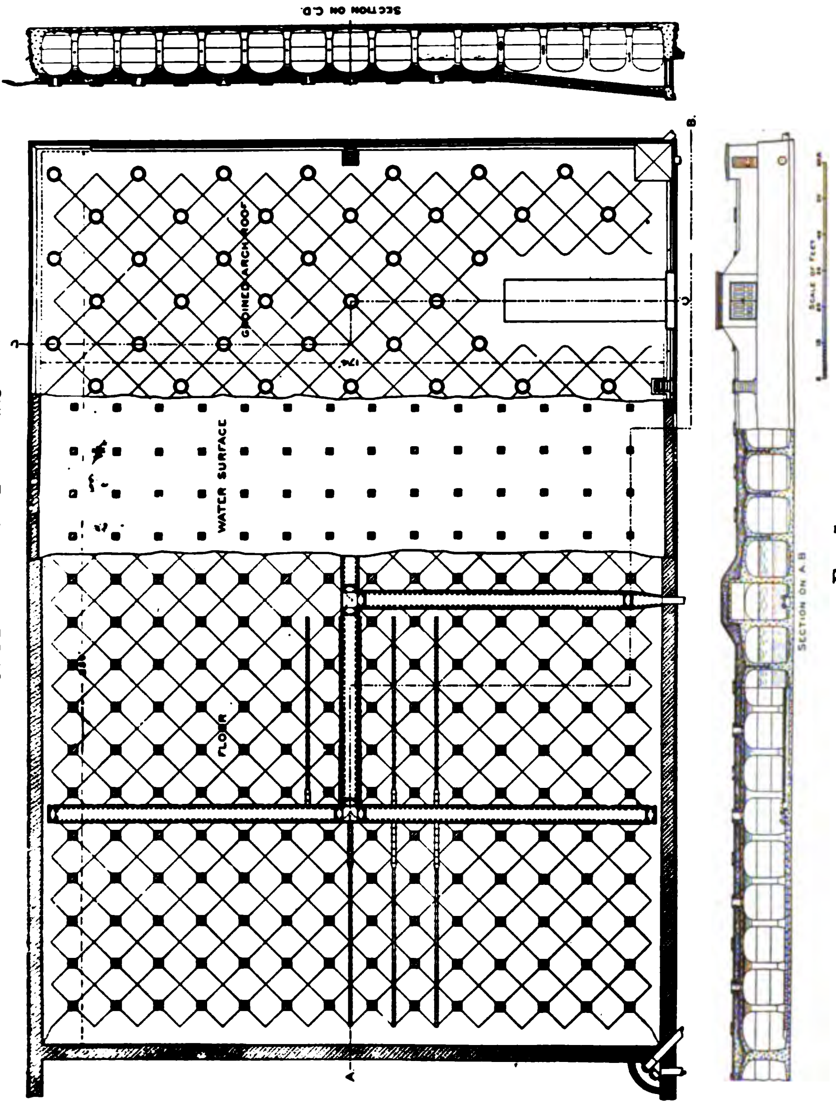
On being discharged from the pumps, the water passes over a stilling weir through a series of screens having 5, 6, 10, and 24 wires to the inch. Every screen can easily be raised by a traveling hoist, to be cleansed by a stream of water from hose nozzle, because the net area of the waterway is at least twice the cross-section of the conduit.

CHARACTERISTIC SECTIONS OF COVERED FILTER BEDS
PROVIDENCE WATER WORKS



Nº 10 SOUTH
FRONT ELEVATION OF ENTRANCE
SECTIONAL ELEVATIONS THROUGH ENTRANCE ETC. SHOWING FRONT AND REAR WALLS
Scale
SECTIONAL ELEVATIONS SHOWING DIVISION AND SIDE WALLS
SECTIONAL ELEVATIONS SHOWING FRONT AND REAR WALLS

FIG. 4.



SECTIONAL PLAN AND ELEVATIONS OF COVERED FILTER BEDS
PROVIDENCE R I WATER WORKS

FIG. 5.

The water flows in conduits of concrete and vitrified pipe to the filters, entering each by means of a 24-in. gate and flooding the sand to a depth of 4 ft. The 24-in. waste gate and overflow are also located in the same gatehouse.

Each filter consists of a concrete tank, 9 ft. in depth and 1 acre in area. The cover consists of groined vaulting supported by 20-in. concrete pillars 12 ft. from center to center. The filtering material consists of 4 ft. of sand on 1 ft. of gravel.

Within the gravel layer is placed the underdrain system. The pipe drains are laid upon the floor, completely covered with gravel, and consist of 6-in. circular and 12-in. split vitrified pipe, laid with ¾-in. open joints. These enter into the main drains of vitrified pipe or reinforced concrete. The main drains receive water from four groups of laterals arranged in the manner shown in plate. These main collectors are arranged in this manner in order that the rate of filtration may be more nearly uniform over the whole area of the bed.

The filter sand, obtained within one-half mile of plant, has an effective size of .34 and an uniformity coefficient of 2.5. The gravel is laid in three layers, the first being 7 in. in depth and between 1 in. and 2 in. in diameter, the second 2½ in. in depth and between ⅜ in. and 1 in. in diameter, and the third 2½ in. in depth and varying between ⅜ in. and a sand coarser than the filter sand.

The following views illustrate the construction of the underdrain and the main collectors, also the placing of gravel and sand within the filters.

The beds, five on each side, face each other on opposite sides of the main court, which is 100 ft. wide. In this court are the raw water conduits, filtered water conduits, pressure water pipes, etc. An 8-in. water main extends the length of this court, supplying water for washing, transporting sand, etc. The regulator houses are also located within this court, one in the center of a group of six beds, and the other in a group of four beds.

The water, after passing down through the sand, flows through drains and collector pipes into the control chambers in the regulator house, there being a chamber for each filter. These chambers have 20-in. inlet and outlet gates, by means of which the rate of flow is controlled. Just outside the regulator house, on

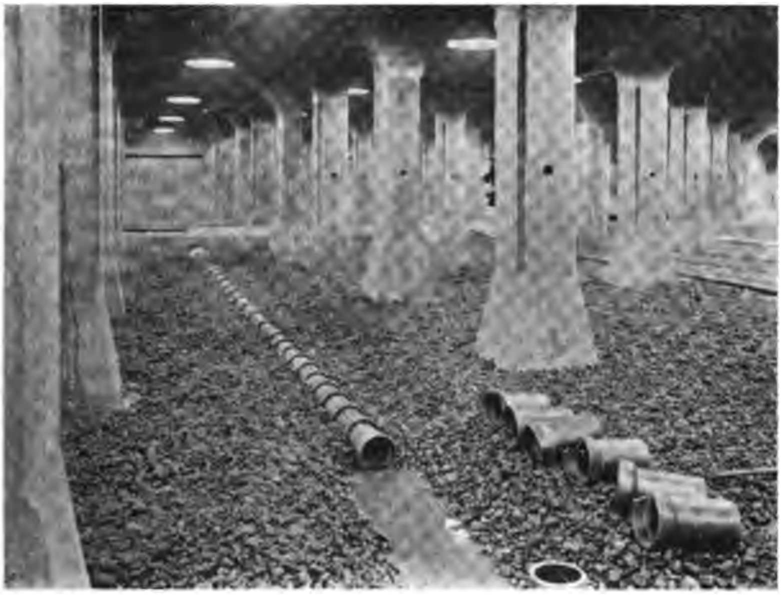


Fig. 6. Interior of Filters showing Underdrain.

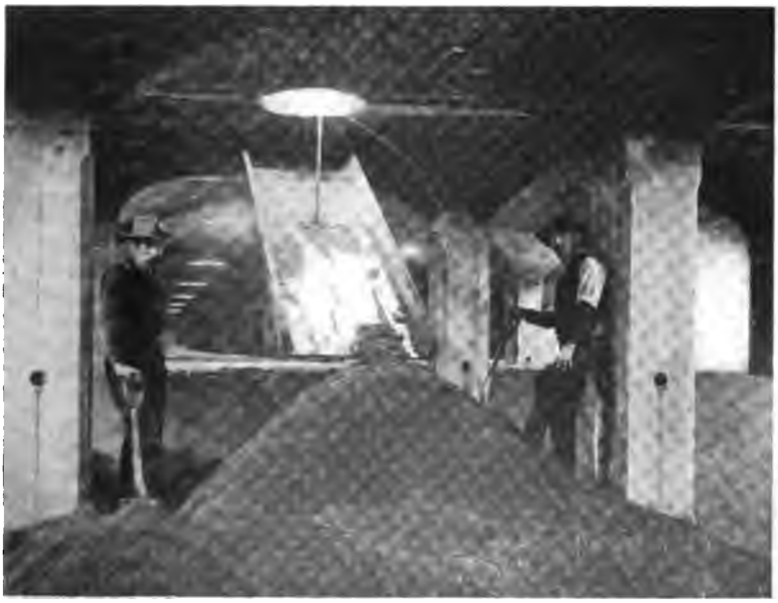


Fig. 7. Depositing Sand in Filters.

PLAN OF COVERED FILTER BEDS
PROVIDENCE R.I. WATER WORKS
AT PETTACONSET PUMPING STATION

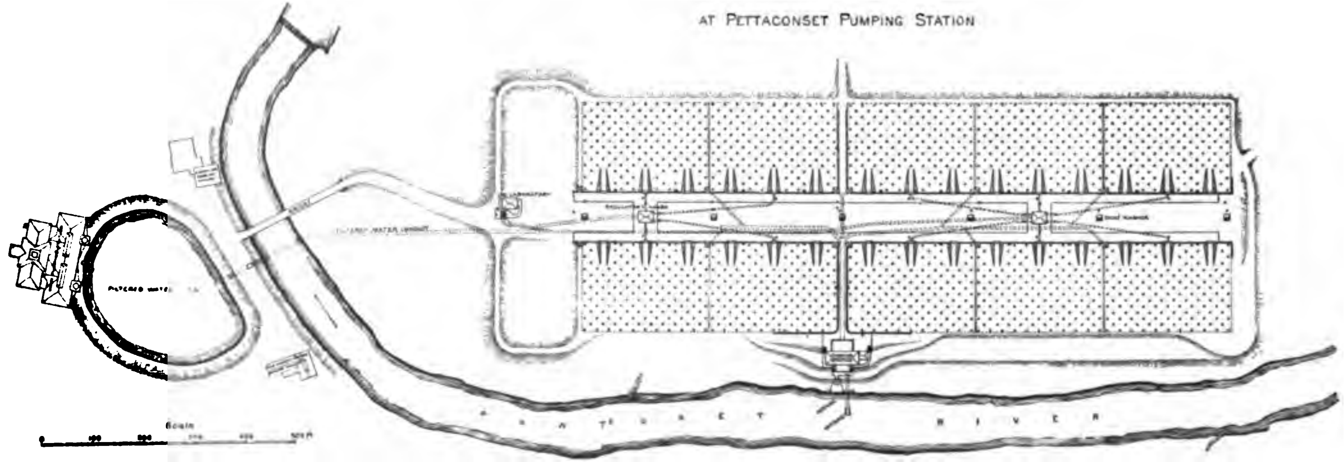


Fig. 8.

the line from each filter, is a Venturi meter, coming from which are two lead-lined pipes connected with float-tubes in the house. Fine wires connect these floats with an indicating apparatus. A third tube is connected by means of a lead-lined pipe with the raw water on the sand, and also with the indicating apparatus upon which the rate of flow and loss of head are read. There is no automatic control, everything being done manually. The readings are taken at four-hour periods.

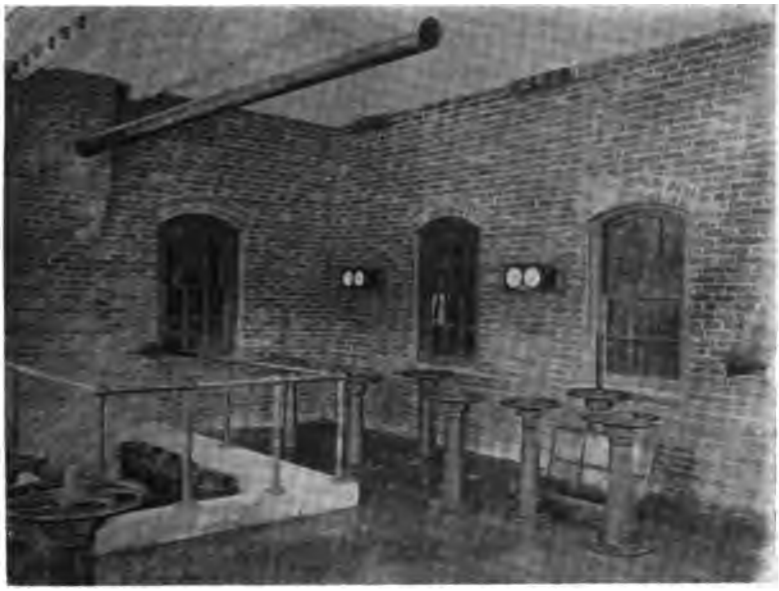


FIG. 9. INTERIOR VIEW OF REGULATOR HOUSE. SHOWING FLOAT-TUBES, REGULATING APPARATUS, ETC.

Besides these gates mentioned, there are 20-in. gates that connect the different filter chambers together in order that each bed when cleaned may be filled to above the surface of the sand with filtered water before admitting the river water.

The 30-in. filtered water conduits leading from each regulator house unite in a 48-in. conduit, which passes beneath the river into the basin at the Pettaconset Pumping Station. The water is pumped from this basin into the Sockanosset Reservoir, the main distributing reservoir of the system.

In cleaning an uncovered bed, the dirty sand was scraped or skimmed with a square-ended long-handled shovel into windrows running across the bed from front to rear.

A continuous line of wheelbarrows was run around by these, filled by the men shoveling, and dumped in piles in the center court. This method took about three hundred man-hours.

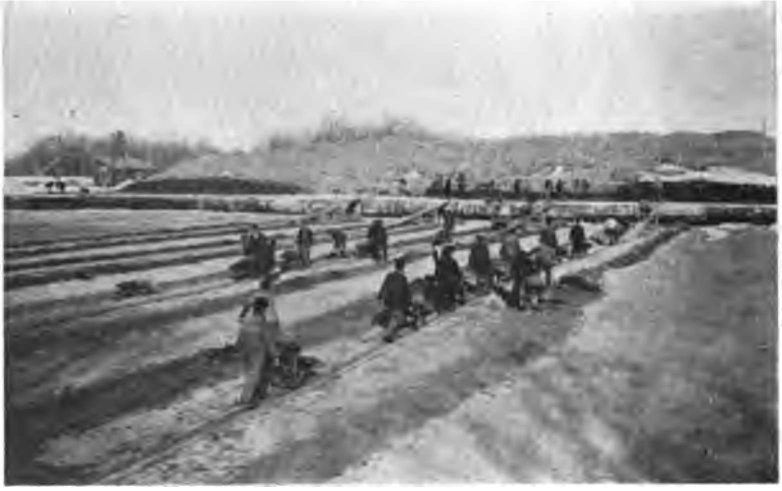


FIG. 10. WHEELING SAND.

After the beds were covered, the method of cleaning was changed. The dirty sand was piled in the beds instead of being windrows, to maintain the surface of the sand more evenly, and the wheelbarrows were run in, stopped, and after being filled run out into court.

This method takes about one hundred and thirty man-hours in summer, and about one hundred and fifty in winter.

The sand within the court is washed and replaced once a year. It is shoveled into portable ejector boxes and conveyed by water, through hose and wrought-iron pipes, to washers.

These washers are of the same type as those used in Washington, D. C. They consist of two iron hoppers, into the first of which the dirty sand and water are discharged, the water passing over a lip into a settling tank, while the sand passes down against an upward flowing stream of water to the bottom of the hopper. The sand is then ejected from the bottom of the first hopper into the second, where the process is repeated.

The sand ejected from the second hopper is transported by means of wrought-iron pipe and hose on to the tops of the filters into a third hopper, where the dirty water is separated from the sand, and the latter discharged from the bottom of the hopper through a manhole, where it is distributed by means of movable troughs over the surface of the bed by the men. The dirty water passes from the third hopper into a baffle box, where any fine sand passing over may be caught and returned.

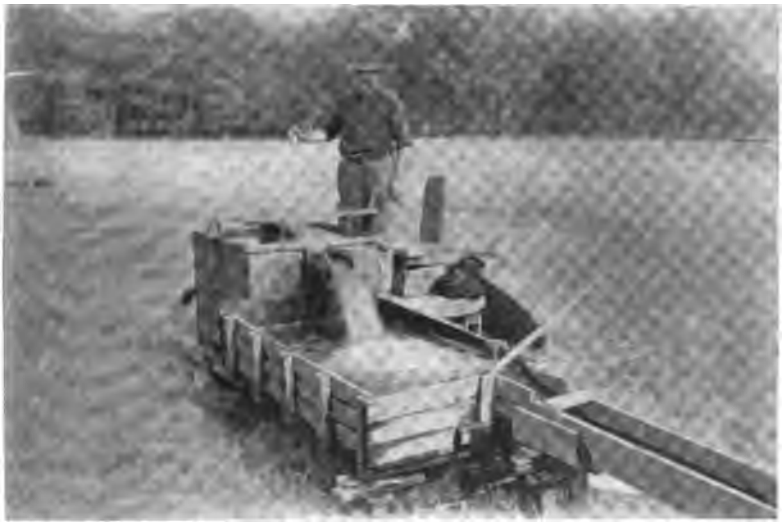


Fig. 11. View of Third Hopper and Baffle Box.

Previous to replacing sand, after the bed is cleaned the stained sand extending from the surface down varying depths, usually about 6 in., is thrown back in sections. The washed sand is replaced in each section and the stained dirty sand replaced again on top. This method allows the bed to regain its efficiency more quickly than when the clean sand was placed on top. This method was continued from 1909 up to the present year, 1917, when a change had to be made, as subsurface compaction, which had shown up first in 1915, had become so bad that it was necessary to remove the sand to below the compacted layer, which was 16 in. deep in some places.

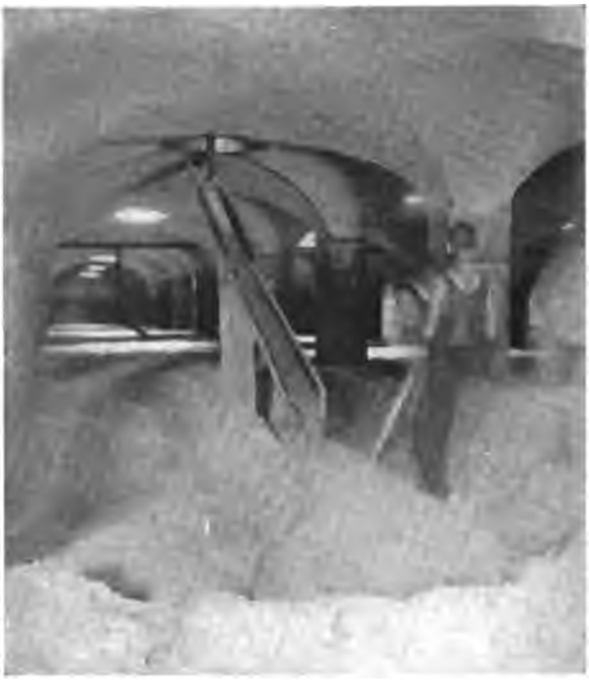


FIG. 12. ILLUSTRATING THE USE OF MOVABLE TROUGHS IN DISTRIBUTING SAND FROM THE THIRD HOPPER, ON TOP OF THE BED, OVER THE SURFACE OF THE FILTER.

The water pressure delivered in the main court would not permit of economical transportation of sand from the filters, as it was only 65 lb. static. By the introduction of a "booster" pump, the pressure has been raised to 150 lb. static, giving a working of over 115 lb. A new system of piping was introduced into the filters also, one line for water, another for ejecting the sand.

With the old pressure of 65 lb. static, about 7½ cu. yd. per ejector-hour of sand could be replaced from the piles in the court; 20 cu. yd. have been replaced from the pile per ejector-hour, with a pressure of 150 lb. static. The pressure was increased at first to 125 lb. static, which gave a fluctuating working pressure of between 70 and 90 lb., while after increasing to 150 lb. static, the working pressure is between 107 and 118 lb.

SOME STATISTICS OF SAND WASHING.

Number of Bed.	Ejector Hours.	Depth of Sand.			Cubic Yards Replaced.	Cubic Yards per Ejector Hour.	Water used to Clean Sand in Gallons.	Gallons per Ejector Hour.	Remarks.
		Removed from Bed in Inches.	Replaced from Sand Pile in Inches.	Total Replaced in Inches.					
4	607.	16	16	32	4 288	7.06	2 154 152	3 549	Washed with static pressure of 125 lb.
6	590.5	14	12	26	3 484	5.90	7 834 976	13 268	
2	360.5	12	8	20	2 680	7.43	5 003 856	13 880	
1	312.5	13	11	24	3 216	10.29	4 889 456	15 646	Washed with static pressure of 150 lb.
10	328.5	12	15	27	3 618	11.01	5 413 408	16 479	

With a pressure of 85 lb. the nozzles in the ejector boxes were about $\frac{11}{16}$ in. in diameter with 1¼-in. throat, while with a pressure of 100 lb. or over the nozzles had to be reduced to $\frac{9}{16}$ in. diameter with the same throat. The nozzles in the washers are ⅜ in. in diameter in the first hopper, used to eject sand from the first to the second hopper, while that in the second, used to transport sand from the washer to the top of the bed, is $\frac{11}{16}$ in. in diameter. Through the necessity of completing the washing of the extra sand as quickly as possible, four or five ejectors, some from the pile and some from inside of the bed, have been connected with either two or three washers. Time is saved by using four discharge hoppers on top of beds, two at a time, the other two being moved to the next set-up. About twenty minutes is saved on each set-up.

The improvement obtained by use of filters has been marked.

The river water, acting as a main drainage channel from the densely populated mill villages, has a rather high color, normally about 45, and rarely exceeding 70. The average reduction in color by means of sand is about 35 per cent. The number of bacteria in the water is not very high, normally ranging from 50 per c.c. to 25 000 per c.c., the higher number showing only after heavy storms. The average is about 1 500 per c.c.

The presence of B. coli in the river water is constant down to $\frac{1}{10}$ c.c., and many times showing in $\frac{1}{100}$ c.c., while it is rarely found in less than 10 c.c. in the filtered water, except after replacing the sand, when, for a few days, B. coli may be found in 1 c.c.

Typhoid fever was not prevalent in Providence previous to the installation of the filters, — at least epidemics could not be traced to the water supply, — so no figures can be given showing any reduction through the use of filtered water.

The following series of tables is given, showing statistics of the operation of the beds and results of filtration.

QUANTITY OF WATER FILTERED BETWEEN SCRAPINGS IN GALLONS FOR 1916.

No. of Filter.	Maximum.	Minimum.	Average.	Average Maximum Loss of Head in Feet.
1	111 540 000	15 370 000	38 200 000	4.20
2	129 160 000	21 470 000	47 080 000	4.29
3	81 280 000	20 660 000	36 110 000	4.42
4	122 580 000	22 470 000	40 850 000	4.29
5	66 240 000	19 510 000	35 890 000	4.30
6	94 730 000	7 590 000	38 350 000	4.36
7	90 440 000	17 510 000	43 340 000	4.32
8	103 720 000	18 700 000	41 450 000	4.39
9	76 480 000	3 320 000	38 890 000	4.30
10	97 930 000	21 200 000	40 050 000	4.31
Whole Plant	129 160 000	3 320 000	40 020 000	4.32

MONTHLY AVERAGES OF BACTERIA PER CUBIC CENTIMETER.

(24-Hour Counts on Standard Agar at 37½° C.)

1916.

MONTHS.	RIVER WATER.			FILTERED WATER.			Average Per Cent of Bacteria Remaining.	B. COLI IN FILTERED WATER.			B. COLI IN RIVER WATER.				
								Times Tested per Month.	No. Times Present.		Times Tested per Month.	No. Times Present.			
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.			1 C.C.	10 C.C.		$\frac{1}{100}$ C.C.	$\frac{1}{10}$ C.C.	1 C.C.	10 C.C.
January	1 100	100	550	79	4	13	3.2	21	0	16	21	0	21	21	21
February	1 700	200	550	33	3	12	2.7	15	0	6	15	0	15	15	15
March	700	100	350	17	1	6	2.2	18	0	10	18	1	18	18	18
April	700	200	450	11	1	6	1.5	21	0	0	21	2	21	21	21
May	3 200	300	1 300	20	2	7	0.7	19	0	13	19	0	19	19	19
June	2 200	1 000	1 500	27	2	8	0.5	20	0	17	20	10	20	20	20
July	3 000	1 200	2 000	30	3	8	0.4	19	1	18	19	0	19	19	19
August	2 100	900	1 300	23	2	7	0.5	23	1	12	23	1	23	23	23
September	9 000	1 300	3 000	30	3	8	0.3	21	0	16	21	0	21	21	21
October	2 100	300	1 300	41	3	8	0.7	23	0	9	23	8	23	23	23
November	2 300	600	1 500	21	3	9	0.7	22	0	15	22	2	22	22	22
December	3 100	300	1 300	23	5	12	1.5	19	0	5	19	0	19	19	19
Average of Plant			1 250*			9*	1.3*								

*Average of total number of samples taken in year.

PROVIDENCE WATER WORKS. ANNUAL STATISTICS.

Year.	BACTERIA PER C.C. 48-Hour Count, Standard Gelatine.							Average Color Platinum Scale.			Average Number of Cleanings per Bed.	LENGTH OF RUN IN DAYS.			YIELD BETWEEN CLEANINGS. MILLION GALLONS.			Average Rate per Bed per Day in M. G.	Average Maximum Loss of Head in Feet.	COST OF FILTRATION PER MILLION GALLONS.			Estimated Population Supplied.	Consumption.		
	Raw Water.			Filtered Water.			% Removed.	Raw Water.	Filtered Water.	% Removed.														Million Gallons.		Av. Daily per Capita. Gal.
	Max.	Min.	Av.	Max.	Min.	Av.						Max.	Min.	Av.	Max.	Min.	Av.			Pump.	Filter.	Total.		Total Yearly.	Average Daily.	
1906	7 500	200	1 470	264	2	25	97.3	. .	. .	30	13.6	50.9	8	22.4	121 255	26 339	48 156	2.24	4.0	$3.00	$1.99	$4.99	219 800	5 492	15 045	68
1907	8 000	120	1 030	271	1	16	98.0	54	35	35	15.0	56.0	11.5	23.0	140 428	22 566	54 839	2.37	4.9	3.28	4.20	7.48	225 700	5 923	16 227	72
1908	9 000	100	1 200	300	1	16	97.8	43	27	35	12.0	72.9	11.8	25.2	161 704	23 940	55 139	2.08	5.3	3.48	2.03	5.51	231 900	5 693	15 555	67
1909	2 000	150	1 930	1 500	1	31	97.5	46	30	35	13.6	61.5	10.4	23.7	115 595	15 620	40 686	1.72	4.9	3.23	2.05	5.28	237 200	5 532	15 156	64
*1910	25 000	100	2 490	1 200	1	41	98.3	48	33	31	18.0	84.3	6	18.8	142 324	10 312	33 772	1.73	4.8	3.20	1.78	4.98	246 000	5 684	15 572	63
1911	8 000	100	1 350	200	1	13	98.6	48	33	30	14.1	61.7	8	23.7	117 345	14 396	42 755	1.72	4.3	2.98	1.59	4.57	254 100	6 055	16 590	65
1912	18 000	100	1 010	350	1	11	97.9	45	31	31	15.5	51.4	9.5	22.2	108 100	18 310	42 636	1.92	4.2	2.72	1.56	4.28	260 600	6 463	17 660	68
1913	10 000	100	1 500	150	1	10	98.4	46	32	30	16.8	47.7	5.3	20.3	96 880	14 080	38 720	1.93	4.0	3.00	1.59	4.59	267 000	6 453	17 681	66
1914	20 000	100	1 350	180	1	10	98.4	45	31	32	17.1	49.9	4.9	19.9	109 920	9 260	38 650	1.92	4.0	3.15	1.71	4.86	273 400	6 470	17 726	65
1915	6 000	100	1 200	70	1	8	98.7	49	33	33	14.7	61.0	9.2	23.5	117 630	7 100	44 460	1.88	4.2	3.07	1.66	4.73	278 727	6 456	17 194	62
1916	9 000	100	1 250	79	1	9	98.7	51	33	35	17.3	59.3	2.3	19.5	129 160	3 320	40 020	20.45	4.3	2.79	2.13	4.92	284 400	6 597	18 025	63

* 24-hour counts on Standard Agar at 37½° C. substituted for Standard Gelatine.

OPERATION OF FILTERS IN 1916.

Number of Filter.	Times Scraped.	Total Hours in Service.	Total Quantity of Water Filtered during the Year, in Gallons.	Average Quantity of Water Filtered between Scrapings.	Average Quantity of Water Filtered per Day.
1	18	8 216.0	687 650 000	38 200 000	2 010 000
2	15	8 187.5	706 180 000	47 080 000	2 070 000
3	19	8 131.5	686 110 000	36 110 000	2 030 000
4	17	8 131.0	634 510 000	40 850 000	2 050 000
5	19	7 969.5	681 990 000	35 890 000	2 050 000
6	18	8 144.0	690 310 000	38 350 000	2 040 000
7	16	8 176.0	693 470 000	43 340 000	2 040 000
8	17	8 098.0	704 690 000	41 450 000	2 080 000
9	17	7 969.5	678 060 000	38 890 000	2 040 000
10	17	7 996.5	680 790 000	40 050 000	2 040 000
Total			6 903 760 000		
Average of Plant	17.3	8 101.9		40 020 000	2 045 000

Lengths of runs in days:
Maximum, 59.3
Minimum, 2.3
Average, 19.5

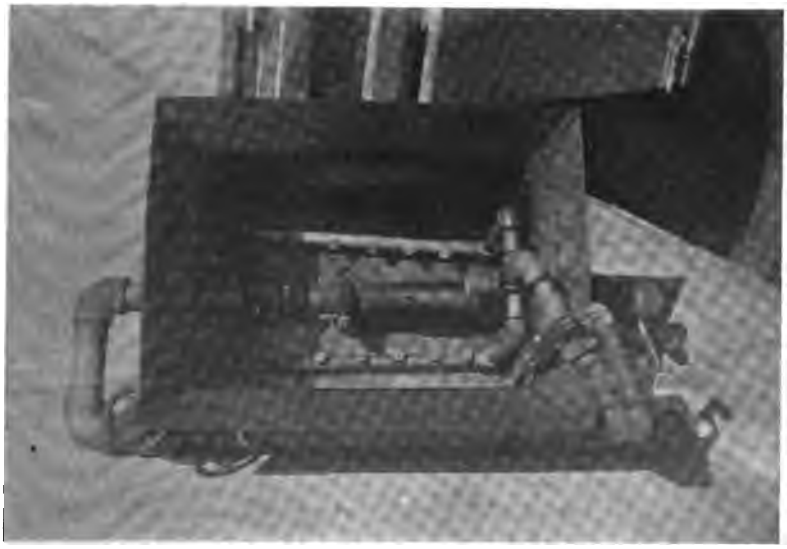


FIG. 13. SAND EJECTOR BOX.

The necessity of frequently changing the two liquefying pipes, caused by the wear about the small holes, made much delay and expense. In an emergency the holes were reamed out to about $\frac{5}{8}$ in. in diameter, and wooden plugs, with $\frac{3}{16}$-in. holes through them, were driven in, forming a nozzle that wore much longer than the iron pipe did. These plugs were made about 1 in. long, $\frac{3}{4}$ in. in diameter at top, and 1 in. at the smaller end. These made a cheap nozzle that could be replaced very easily.

CONSTRUCTION OF THE PHELPS BROOK DAM. WATER SUPPLY FOR HARTFORD, CONN.

BY J. F. SHAUGHNESSY, ASSISTANT ENGINEER, HARTFORD WATER WORKS, HARTFORD, CONN.

[*Read November 14, 1917.*]

The Phelps Brook Dam is situated in the town of Burlington, Conn., in a range of hills west of the village of Collinsville and about one and one-quarter miles to the southwest.

The brook breaks through the hills at a point approximately the middle of an arc of a circle whose center is upstream 1 400 ft.

After providing for the direction of traffic around the dam site, the control of the stream during the construction of the conduit and lower parts of the gate chambers was in order. A wooden flume 400 ft. long, 12 ft. wide, and 4 ft. deep, was built south of the center line of the conduit, and this proved to be of ample size to carry the stream.

When the flume was completed and the water had been turned through it, the excavation for the conduit trench was begun. About two thirds of this was in rock, the foundations for both gate chambers being included in this portion. Blasting was necessary for a distance of about 100 ft. In order to guard against opening up the already seamy rock, light charges of 40 per cent. dynamite were used in shallow holes. Near the bottom of the trench loose pieces were barred out.

All surfaces not showing clean were gone over thoroughly with picks, to remove anything that would prevent actual contact between the ledge and concrete to be poured above it. After a scrubbing with water and wire brooms, a coating of dry cement was spread, about one-quarter bag to the square yard. This was then wetted to the consistency of thick paint and brushed in with wire brooms. On this was placed a coating of thin mortar, consisting of one part cement to three parts sand. The pouring of the concrete was immediately started on this prepared surface.

The conduit is of the horseshoe shape, 6½ ft. high by 6½ ft. wide, and varying in thickness from 10 in. to 18 in., according to the cover above.

The reinforcing was 1 in. twisted steel bars placed about 12 in. apart and 3 in. from the inner and outer faces running longitudinally. Two other rows attached to these and running at right angles 12 in. apart completed the reinforcing in the arch.

The forms for the invert and outside of conduit were of wood, and built as the work progressed. The inside forms were of metal and furnished by The Blaw Company. The concrete in the conduit is a 1:2:4 mix. A ¾-yd. portable Smith mixer was placed near the part of the conduit under construction, being moved from section to section as needed, making a short carry for the barrows.

Both the metal and wooden forms were given a coat of form oil before receiving any concrete, and during the pouring the concrete was spaded to assure smooth surface after completion. Special spades were made for use in the arch, to enable the workmen to reach between the reinforcement rods.

Contraction joints are provided every 25 ft., ingot iron water stops being inserted at each joint.

The ends of sections first built were made smooth except that 4 in. of 8-in. by ⅜ in. iron were left protruding. Before the adjacent sections were started, these ends were coated with asphaltum paint. The outer ends of each section were treated in like manner, making a practically water-tight joint every 25 ft.

The gate chamber to the elevation of the top of the conduit was built in as part of that structure, other sections 12 ft. high being added as the dam was carried up.

The bolts carrying the ladder and gate stem were inserted through the inner forms, being held in their proper positions with 2-in. by 4-in. blocks. The stop plank grooves starting from the intersection of openings in conduit and gate chamber were held securely by timbering resting on the invert and by wiring to the inside of the gate chamber forms. Succeeding lengths of these castings were held by bolting at the bottom to those already in place and by wiring as in those first mentioned.

While the building of the conduit was under way, excavation of the core wall trench was carried on, the deepest part being about 30 ft. below the level of the brook at a point 150 ft. south of the conduit. The material in this cut consisted principally of fragments that had been broken from the ledge, with some silt washed in from the valley above. It was removed by operating a derrick with a clam shell and orange peel buckets attached. A similar but smaller depression was encountered 100 ft. north of the conduit and treated in the same way.

After the material above the ledge and along the line of the core wall had been removed and the grouting done in the low section, the building of the core wall began. A section 30 ft. long and 21 ft. wide was cleaned as described, in preparation of foundations in the conduit, the same application of cement and mortar being used.

The core wall was built 8 ft. thick up to the elevation of the brook, about 430 above sea level, and tapered to 2 ft. thick at the water line, elevation 485. From 485 to 490 the uniform thickness is 2 ft.

At the bottom are two aprons, one extending 10 ft. from the upstream and one extending 3 ft. from the downstream face, making in all a 21-ft. contact between the ledge and the concrete. These aprons were built to such a height that at any point the ledge was covered with at least 2 ft. of concrete.

The forms for the sections in contact with the ledge were generally built of wood, as this material could more easily be made to conform to the varying shapes of the rock encountered. Above the first lifts the Blaw forms were used. These forms were made of channels each side consisting of three parts, a center piece 36 in. deep, with a 6-in. piece bolted on either side. Through the center of these 6-in. channels, and at intervals of 5-ft., were passed ⅜-in. rods. Struts cut to a length equaling the thickness of the core wall kept the forms at the proper distance apart, while a set screw on the rods outside the forms prevented spreading. In each completed lift the upper channel was allowed to remain in place and became the lower channel of the form for the lift above.

At the end of each 30-ft. section, a contraction joint with water stop is provided. The water stops are placed in grooves varying in size from 4 in. by 30 in. to 3 in. by 16 in., according to thickness of wall. In the middle of each groove was inserted 4 in. of the 8-in. water stop. These contraction joints were begun at the ledge and carried vertically to the top of the wall. The ingot iron is given a 6-in. lap, and is bolted wherever joints are broken.

Three keys were inserted at the top of each layer while the concrete was fresh. Two rows of keys were fastened to the forms leaving grooves 4 in. wide on the bottom, 8 in. wide on top. The center groove was triangular, 8 in. wide on top. All are 6 in. deep.

Each layer of concrete was cleared of laitance loose material and washed before being coated with cement and mortar in preparation for the layer above it.

The material for the construction of the earth embankment came from the basin above the dam. A quarry was opened on the hill to the south, from which rock was delivered to the crushing plant by gravity.

Against the faces of the core wall on both sides was placed loam. On the lower side a uniform width of 15 ft. was carried from the ledge to the water line. On the upper side, the loam is 30 ft. thick, at the brook level being carried from a point 10 ft. outside the apron to this maximum of 30 ft. and brought in at a 2½ on 1 slope, being 8 ft. thick at the water line.

Outside the limits for the loam, gravel was used for the filling except that the upstream face of the dam was covered by riprap from the bottom to an elevation 10 ft. below the water line and from that elevation to 5 ft. above the water line with paving, and the entire face of the downstream side had a covering of loam 1 ft. deep.

In distributing the gravel fill, care was taken to put the coarse, heavy gravel nearest the outside, while the finer gravel was placed nearer the loam.

The gravel was rolled in layers not exceeding 1 ft. in thickness, and the loam in layers not exceeding 8 in., or tamped in those not exceeding 4 in.

At the bottom of the deep cuts, it was impossible to use the heavy rollers required on account of the lack of space in which to operate them, so, instead of rolling, puddling was substituted. For a space of 10 ft. outside the apron the loose material was removed from the ledge, then the hole was filled with enough water so that the loam when dropped in was wholly covered. This portion of the loam was dumped from the trains at a place convenient to the derrick that had done the excavating and by it deposited where required.

Loam and gravel were brought to the embankment in 4-yd. dump cars, 18-ton locomotives were used, carrying trains of from 3 to 6 cars as the elevation of the dam increased.

At Phelps Brook Dam there was little trouble from the water encountered below the level of the brook, one pulsometer pump of 4-in. discharge being sufficient to care for it at any time.

DISCUSSION.

PRESIDENT SAVILLE. There are one or two things in the paper I should like to speak of particularly. Mr. Shaughnessy speaks of the Blaw forms being used. They were about 4 ft. wide and 30 ft. long, perhaps. They were moved by the traveling derrick that handled the concrete buckets. At first they did very good work; the surface of the concrete came out nice and smooth, and we were very much pleased with them. But, after being used for some little time and moved around with the derrick, they became shaky, would sway when moved. They did not give good satisfaction towards the end, and at the very last, wooden forms were used which were very much more efficient. The fault, if you can speak of it as a fault, was in not having stiffners enough in the forms themselves to keep them rigid. The Blaw people might say the fault was in the method of using them; that, if we had treated them with more respect, they would have done better; that they were not intended to be knocked around as was done. Be that as it may, on construction work you have to move things as best you can.

Another point which may be mentioned was the method of placing the concrete. The rock, as intimated in Mr. Shaughnessy's paper, was brought down by gravity to a crusher, crushed, raised by a derrick and orange-peel or clam-shell buckets to a considerable height, and then dropped into the hopper of the concrete plant which was at one end of the work. This hopper had two compartments in it, one for stone and one for sand, from which these materials flowed by gravity to a mixing platform and into measuring hoppers at that point. After this was discharged into the mixer, the cement was added and the materials thoroughly mixed. It was then raised about 10 ft. on an elevator and dumped into a chute and delivered at the elevation where we were working on the dam. It was then dumped into small cars and run along the side of the core wall, the locomotive taking a flat car with two of those buckets. At the point where the concrete was put into the dam, there was a very awkward derrick, which moved the forms and took this concrete up and dumped it into the forms. We found as the work progressed that that was a very unfortunate place to have the derrick because it interfered with work on the embankment. The upstream portion of our soil core, which was one of the defenses against percolation, was on that side. This track and derrick and the maneuvering of it was a very great nuisance, so that we were not able to do the work as efficiently as we would have liked to do on the upstream side. A suggestion which came from this work was that the next time any work of this kind was done all the machinery should be placed on the downstream side, leaving the upstream side clear.

The foundation rock was a schist, soft in places, and it was interesting to find seams that had formerly been filled with pegmatite, which had become softened to a clay-like material by the water which had percolated down from above. Some of it was almost the consistency of putty, and in other places the material had become like chalk. It could be picked out with the fingers or carved with a knife, and if it got wet it became putty-like again, smooth and slick. That stuff was all taken out. Then grouting was started. The grout holes were arranged in three rows about 7 ft. apart and 25 ft. deep. In the first place those holes were filled with water through a meter to show how much water was lost. If a large amount of water was needed it was taken as evidence of a big seam. A special form of pipe was then put in, with a rubber dam, which by screwing together expanded a rubber washer that closed the hole tightly at the top. Water pressure was then put on the hole, something more than 10 or 15 lb. perhaps; anyway, more than any pressure which would come on that point from the water in the reservoir. That proved to be a most efficient way of finding any holes, seams in the rock, or slabs. The rock lay in some places almost vertically, and it was almost impossible to find any seams in it; but by putting water pressure on, seams would be uncovered by the blowing off of large slabs. Sometimes some of the concrete would be blown off. We found it a most efficient way of searching out seamy rock, by putting water pressure on it.

The material of the dam was loam; that is, from about 30 ft. out on the upstream side was this layer of loam, using black loam from the valley above and about 8 in. of yellow loam underneath, great care being taken not to get too deep into the yellow loam so as to meet the sandy material. Outside of that was placed clean gravel, the finer materials, so far as we could, being placed toward the inside and the coarser toward the outside; and outside of that a paving of heavy blocks of stone; and we chinked that with smaller stone, making a very efficient armor, as it has proved, against the action of the waves.

MR. FRANK A. FULLER. What kind of cement did you use?

PRESIDENT SAVILLE. Lehigh and Knickerbocker both were used.

MAINS.

TOPICAL DISCUSSION.

Mr. George C. Bertram. I represent the Lock Joint Pipe Company, and I should be very glad to give you any information I can on the subject of reinforced concrete pipe.

For a number of years, we have been experimenting with reinforced concrete pipe for pressure purposes, not so much for street work, but for large supply mains. We have carried on a number of experiments and tests on pipes varying in size from 24 in. in diameter to 108 in., and have drawn the conclusion that it would not be economical to build pipes for a pressure higher than 125 ft.

We recommend and use a very low safety factor in our steel, namely 10 000 lb. per sq. in. This we found necessary on account of the stretch or elongation which develops in steel when put under pressure. Although we have tested 48-in. pipe up to 96 lb. per sq. in., we do not consider this economical owing to the excessive amount of steel reinforcement required.

In our experiments as well as in our construction work, we found that it was absolutely necessary to provide for contraction and expansion at every joint. We have developed an expansion and contraction joint that has proved very satisfactory.

We have built a number of large lines, both in diameter and length. The first large construction was the 108-in. inside diameter pipe for the city of Baltimore. This is about one mile long, and is operating under a 75-ft. head. We have since built a number of other lines, one at Dallas, Tex., a sewer force main, approximately 14 400 ft., operating under an average head of about 50 ft. This line was a 36-in. inside diameter, and the pipe was manufactured in 8-ft. lengths, a copper expansion joint being used in every joint. When this line was tested, clear city water being used, it showed a leakage of about 17 000 gals. in its entire length in twenty-four hours.

We also built a line for Fort Worth, about 14 500 ft., of which 1 528 ft. was 36-in. pipe, the balance being 48 in. inside diameter.

This line operates under an average head of about 45 ft. This line, when tested, showed a leakage of less than 15 000 gal. in twenty-four hours of its entire length.

We now have under construction about ten miles of 66-in. diameter pipe for the Greater Winnipeg Water District. We have built a twenty-seven and one-half mile line of 42-in. pipe on the Pacific coast at Victoria. We have built a number of smaller pressure lines for both water and sewer purposes. At the present time there is being built in Philadelphia, to be operated under about a 15-ft. head, a large sewer siphon about 6 000 ft. long.

I wish to call your attention to the fact that we recommend the use of contraction or expansion joints in every joint, and this recommendation is based on the examination made of lines that have been in operation for some time. I have personally examined a line where for a distance of 120 ft. there has been no sign of contraction and then every joint would open, for a number of joints, there being no regularity as to where the contraction takes place; so in all our construction work we use an expansion or contraction joint at each and every joint.

We feel that this is a particularly good time to call the attention of the Association to reinforced concrete pipe lines, as same can be constructed at a very much lower cost than either cast iron or steel. As an example, we are now constructing an outfall sewer line in Lake Erie for the city of Cleveland, 84 in. in diameter. This was taken in competition with steel pipe ½ in. thick. The total price for the steel pipe bid on this work was $670 000 in place, and, for the reinforced concrete pipe in place, $360 000. This is but an example of what can be done, and I simply cite this example of a recent piece of construction work. We are making this pipe for the city of Cleveland in 20-ft. lengths, and each piece weighs about 25 tons. The pipe is known as a ball-and-socket type of pipe, flush both inside and outside. We recommend and use pipe in 8-ft. lengths for pressure pipes, whereas our sewer pipe and pipes not used for pressure purposes, we manufacture in 4-ft. lengths. In each and every pressure pipe we provide, at the time we construct the same, a copper ring which has a V-shaped bead formed in it. This is molded in the spigot end of the pipe at the time it is manufactured. This copper joint extends into the joint and overlaps the reinforcement from the bell of the adjoining pipe. We recommend and use a mixture of 1: 1½: 2½ concrete, and do not recommend the use of waterproofing compounds. In fact, have not and do not use the same ourselves.

Mr. S. H. McKenzie. I should like to inquire why you do not use waterproofing.

Mr. Bertram. In answer to Mr. McKenzie's inquiry in regard to waterproofing, we have not found any waterproofing as yet that we would recommend using. A Portland cement concern makes what they call a waterproofing cement, and their representative came to me in Cleveland and wanted us to use their waterproofing cement, and use a leaner mix, stating we could save money by doing this. Upon investigation, I found that we should not get as good results, and the final cost, owing to the increased price of this so-called waterproofing cement, would make the concrete cost more money than in the mix we were using there, namely a 1: 1½: 2½ concrete.

We have found that a small percentage of clay apparently does not harm the concrete and does waterproof the steel better than any of the so-called waterproofing compounds offered on the market. I would call your attention to the experiment and test made by the Aberthaw Construction Company, of piles in salt water that were suspended from the Charlestown Navy Yard dock.

Mr. James E. Blinn.[*] I can bear out the statement which Mr. Bertram has just made about making concrete waterproofing. For twelve years now in the Board of Water Supply Laboratory we have tested most of the medicines which have been suggested for making concrete waterproof, and our engineer inspector has repeatedly told me that he has not yet found one which was any good, and some of them are positively injurious. The best way to make waterproof concrete is to properly proportion it and mix it long enough. People are only beginning to realize, I think, the importance of sufficient mixing. This idea that you can turn a concrete mixer over a few times and turn the half-combined ingredients out and call it concrete has got to be given up, or there will be more trouble with concrete when used under trying conditions. Thorough mixing not only makes your concrete more watertight; it makes it work better in the forms, and in every way more satisfactory.

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[*] Of New York.

Mr. McKenzie. Wet or dry?

Mr. Blinn. Wet, by all means. The dry process is really the cause of more trouble in concrete pipes than anything else which has ever been used. Not too wet. You have got to use a happy medium. In Winnipeg there is approximately 12 to 20 per cent. of very fine sand, all good and clean, that gave us very satisfactory results with even a less amount of cement than the coarser sand which requires a lot of cement to fill it up.

Mr. Henry R. Buck.* What precautions do you take to insure that the joint at the top is as dense as at the bottom? I should think you would get lots of trouble at the top, that it would settle at the bottom.

Mr. Bertram. We always start with a grout mixture.

Mr. F. N. Speller.† I have prepared a few notes by way of summarizing the status of welded pipe made with the bell and spigot. This is not at all full, it is just to round out the subject and start something. I might state that we have withdrawn all this from the market at the present time, so that there is no object here of accelerating the use of this material. This was done for the sake of conserving steel in the present emergency, for we feel that where emergency water works must be built at this time there are other materials which can be used in most cases, while steel is more necessary, of course, for other work.

Just one point I would like to emphasize in connection with this class of pipe, and that is the matter of reliability. I had the pleasure recently of visiting a number of installations in the Middle West and in California, and the one feature in all the service that struck me most was the fact of the few number of actual failures. What I mean by "failure," as I have said here, is a total collapse of the system, a burst or broken pipe that would completely shut off the supply for any length of time. I should like to mention three localities. For instance, Butte, Mont. The whole record of that system for the last thirty-one years, I think, in which they have been using this class of pipe exclusively, shows that they have had six failures of that class. In Ogden, in twenty-seven years, thay have had one failure; and in Colorado Springs in twenty-five years they have had no trouble of that kind at all.

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* Consulting Engineer, Hartford, Conn.

† Metallurgical Engineer, Pittsburg, Pa.

MR. CARSTEIN.* In this afternoon's meeting there was an interesting discussion on the waste of water, which should be of interest in connection with the talk on pipe, — especially the service pipes as they are mentioned by the President. I think that the time has come when we should pay more attention to service pipe lines, — that is, from the main in the street to the building. Much of the water which is wasted, undoubtedly wastes through rust holes in the steel and wrought-iron pipe which is used for that purpose now. I need not emphasize, I believe, that cast iron has proved its ability to last, — not only last but to carry service uninterruptedly. Where other pipe can cite a twenty-five or thirty year service, cast iron can cite a 250-year continuous service. Now, in the placing of cast iron between the street main and the building, it is quite possible to install it at a reasonable figure, — one that would compare favorably with 1-in. lead pipe. But we are enabled to use a 2-in. pipe instead of a 1-in. pipe when using the cast iron, and thereby get a better capacity, a pipe which will not fill up so readily, one which can be cleaned when it may be filled up with mud or other sediment, and one which will last as long as the mains.

MR. A. B. MCMILLEN† (*by letter*). The National Tube Company has asked me to write you relative to the experience of the Water Supply Company in the use of pipe. I will say that the present water system was installed about the year 1886, and has been gradually added to since that time, and there are now something over thirty miles of mains in use. Formerly, we used galvanized and dipped lap-weld steel pipe with lead joints, but later changed to National coating. Our system is composed wholly of these two classes of pipe.

The lower portion of the city has alkali soil, which is very hard on ordinary pipe, but the coating seems to protect the pipe from the effects of alkali.

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* Of New York.

† President, Water Supply Company, Albuquerque, N. Mex.

Most of the pipe put in thirty years ago is still in good condition, and the results of the pipe used have been highly satisfactory. On account of light weight and long lengths, it is much more economical to lay and handle than cast-iron pipe. As we have not used cast-iron pipe, I have no means of comparing them with respect to length of service.

We have been convinced, however, that the use of the lap-weld pipe with National coating was superior to anything else for our purposes, as you may judge from the fact that we have used no other kind.

MR. B. B. MCREYNOLDS* (*by letter*). We first installed 13 000 ft. of 14-in. Matheson Joint pipe in 1892. This was installed as a mountain flow line at an elevation of from nine to six thousand six hundred feet, the soil conditions being granite rocks and disintegrated granite. The present condition of this pipe is excellent. It shows very little deterioration from rust either inside or out. We have had several rock slides along this line, but have never had a broken pipe. We have had them dented and the joints pulled apart, but have always been able to get the pipe together without patching or installing additional pipe. This is where steel pipe has an advantage over cast iron that works out in practice; that is, the ease in making repairs in remote places and places hard to get to. Mind you, I do not want to claim that steel pipe has the life of cast iron, or that it will take the place of it (we use cast iron for tapped mains exclusively and also for adobe and alkali soil), but from the present condition of this pipe line it will last twenty-five years more and possibly longer.

Since the installation of the above pipe line we have used steel pipe for the following lines:

1904	7 000 ft.	20-in.
1904	22 000 ft.	16-in.
1911	17 000 ft.	16-in.
1906	1 500 ft.	20-in.
1906	15 000 ft.	24-in.
1911	11 000 ft.	12-in.

This is all in good condition, and is giving excellent service.

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* Superintendent, Water Department, City of Colorado Springs.

We have purchased recently and are now installing the following:

9 500 ft. 20-in. National coated pipe.
15 700 ft. 18-in. National coated pipe.
8 700 ft. 16-in. National coated pipe.

I mention this only to show that we consider steel pipe satisfactory after a number of years' trial and service.

Would sum up like this: We have had steel pipe in service from six to twenty-five years, and it has given us no trouble to date. We would recommend this pipe for flow lines where soil conditions are right, above all other kinds. We use it because we consider it better pipe for mountain flow lines and where soil conditions are right, on account of its ease to install and handle and because there is no danger of falling rocks and slides breaking it; also it has a life of more than fifty years.

This is all borne out by our experience with this 13 000 ft. of National Tube Company Matheson Joint pipe, which we have had in service for twenty-five years.

Mr. Eugene Carroll* (*by letter*). As the Butte Water Company has used steel water mains exclusively for the past twenty-six years, I am pleased to give you a few facts concerning our system, particularly as it relates to the distributing system of Butte.

The corporate limits of Butte are very small, but the surrounding country is thickly settled, so that it is impossible to note where the city ends and the country begins. A conservative estimate of the population served by the Butte Water Company would be one hundred thousand people. In addition to the domestic consumers, we cover the district occupied by the large copper and zinc mining companies in this vicinity, which take enormous quantities of water in their operations. On June 30 of this year, which is the date of our last report to the Public Service Commission, we had a total number of eleven thousand and forty-four consumers of all classes, seven hundred and twenty-seven of which are metered, including all of the mining companies, industrial plants, and large consumers. It is not the custom of the company to meter residences, except apartment houses, hotels, and boarding-houses. The average daily consumption of water during the fiscal year ending June 30, 1917, was twelve million six hundred and thirty-six thousand (12 636 000) gallons.

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* Manager, Butte Water Company, Butte, Mont.

As the mining companies and mills vary materially in the amount of water consumed from month to month, and because the water company is liable to be called upon at any time to supply enormous quantities of water to fight underground fires, our pipe system and water supply is more extensive and of larger size than would seem warranted by the number of consumers and house connections.

The water supply is obtained from three different sources. The Basin Creek supply is obtained from a storage reservoir on Basin Creek thirteen miles south of the city, and delivered to the distribution system by two 24-in. influent pipe lines. The Moulton system is supplied from an impounding reservoir seven miles north of the city and conveyed to the distribution system by a 12-in. influent pipe line (which is now being replaced with a 16-in. influent pipe line). The Big Hole system takes its water from the Big Hole River about thirty-two miles south and west of the city, pumping the same across the Continental Divide to a distributing reservoir, a distance of about nine miles from the pumping station, thence by gravity through a 24-in. influent pipe line to the distribution system. The total capacity of the influent supply lines at the present writing is eighteen million five hundred thousand (18 500 000) gallons in twenty-four hours, and the company is about to install an additional pump and pipe line from their Big Hole Station to Butte, which will increase the daily capacity eight million (8 000 000) gallons.

In 1891, the Butte Water Company purchased the small waterworks plant then supplying the city of Butte, and began the enlargement and rebuilding of the whole plant, developing the Basin Creek supply first. The distribution system of the old water plant consisted of ordinary screw-joint pipe from 2 to 6 inches diameter, with the exception of about two miles of 8- and 10-in. National Tube Company's Converse Joint Kalamein pipe, which was laid in 1886, and about four miles of 3- and 5-in. Kalamein pipe with Converse Joint, furnished by the National Tube Company.

Since that time National Tube Company steel pipe has been used exclusively in the distribution system. Originally, Kalamein pipe with converse joint was used, but since 1912 the Matheson Joint pipe, manufactured by the National Tube Company, has been used exclusively. Upon the adoption of the Matheson Joint instead of the Converse Joint, the Kalamein was abandoned and the National Coating substituted. The Kalamein pipe which was in the old system when the present company acquired it in 1891, with the exception of two miles of 5-in., which was removed to increase the size of the pipe, and which was used in other parts of the system, is still in the ground and giving us no trouble. From the records of the old company, the first Kalamein pipe was laid in 1886. This pipe is at present in service on Main Street of Butte. When Main Street was paved, about ten years ago, this pipe was exposed for its whole length for examination and found to be in such excellent condition that it was not considered necessary to replace it for the permanent paving, and it has given no trouble whatever up to the present writing.

The first 24-in. line from Basin Creek, built in 1892, is constructed of banded Redwood Continuous Stave pipe to within a mile and a half of the city limits, from which point a 20-in. Kalamein pipe with Converse Joint was laid for a distance of three miles to the center of town. This pipe is still in operation, and recent investigations show it to be in excellent condition practically all of the way. This Kalamein pipe has given us no trouble at all, and while it is pitted a little where it crosses a swamp, either from electrolysis or acids in the ground, it is in first-class condition to-day.

The Big Hole pipe line was built in 1898–9 and consists of 24- and 26-in. Continuous Stave Redwood pipe with riveted steel pipe where the pressure exceeds two hundred and fifty feet. This line is still in excellent condition, no trouble having been experienced with either the wood or the steel to the present writing. In 1912 an additional 20-in. Kalamein steel pipe was laid from the end of the wooden pipe on Basin Creek line No. 1, a distance of over three miles, connecting to the eastern part of our distribution system to reinforce the water supply. In 1914 an additional pipe line was constructed to Basin Creek reservoir parallel to line No. 1, connecting to the distribution system at the city limits.

This pipe is constructed of 7.26 miles of 24-in. Continuous Stave Oregon Fir pipe and 2.5 miles of 24-in. National Coating Matheson Joint pipe manufactured by the National Tube Company. The contract has been let to the National Tube Company for 18 000 ft. of 16-in. Matheson Joint pipe National Coating to replace the present 12-in. wooden pipe line from the Moulton Reservoir to the city. This is a very old pipe, requiring renewal and increase in capacity owing to developments of that water supply in the past five years.

Summarizing, — the water system of the Butte Water Company has 525 000 ft. of National Tube Company's steel pipe in their distribution system of both Converse and Matheson Joint, with 300 000 ft. of influent pipe lines which consist of 226 954 ft. of Continuous Stave and machine-banded wooden pipe, 38 604 ft. of Riveted Steel pipe, 17 042 ft. of 20-in. Matheson Joint pipe, 3 000 ft. of 20-in. Converse Joint pipe, 13 200 ft. of 24-in. Matheson Joint pipe, National coating, and 1 200 ft. of 26-in. Matheson Joint pipe with National coating.

We have under contract, and about to be constructed, 18 000 ft. of 16-in. Matheson Joint pipe, National coating.

The advantage of steel pipe in the water system of Butte may be summarized as follows: The first cost is much less than cast iron. The cost of laying is considerably less than the cost of laying cast iron. The cost of maintenance and repairs is considerably less for steel than cast iron. The life of steel pipe properly coated is yet undetermined, but the fact that the city of Butte has steel pipe which has been in the ground for thirty-one years and is still in excellent condition would warrant the statement for this community, where the freight rates are high and cost of labor the highest in the country, that it is more economical to use steel pipe than cast iron.

During the past twenty-six years in handling steel pipe for the water works of Butte, we have had only six burst pipes attributable to defective pipe. In laying the Matheson Joint pipe on our 24- and 26-in. influent pipe lines we have the remarkable record of not having a defective joint, although the pressure is as high as 150 lb. per sq. in. in most of the joints.

In designing the plant for Butte and other communities in

Montana, where the writer has been employed as consulting engineer, the consideration which has always governed is a financial one. The life of steel pipe properly coated, as far as the writer knows, is yet undetermined, but for purposes of comparison he has found that, even admitting that the life of cast-iron pipe is twice as long as steel pipe, in a growing community he generally figures that the increased cost of installation of cast-iron over steel, and the increased cost of maintenance and operation of the cast-iron system over a system composed of steel, warrants the substitution of steel for cast-iron pipe. In influent pipe lines the increased capacity of steel pipe over cast-iron is quite a material matter, and where the delivery of pipe over mountainous roads is quite a figure in the cost of construction, the advantage of steel pipe over cast iron is even greater. In a growing community where frequent changes are necessary to increase the capacity, the lesser first cost is quite a factor for the engineer to consider. Particularly in small communities, where the amount of money to be expended is limited and where the desire of the community is to cover the largest amount of territory with the least expenditure of funds, there is no question that the use of steel pipe is advisable.

Owing to unusual conditions, there is a great deal of electrolysis to be contended with in the Butte district. The water company has been endeavoring to have this remedied for many years, and has succeeded in forcing the street railway company to place return feeders to their power stations and make other improvements, tending to reduce the large electrolytic action from that source. Beside the street railway company there are two railroads passing through Butte operated by electricity, as well as many surface and underground electric tramways around the mines. It is questionable, in the writer's mind, if cast iron would not be subject to as great damage as the steel pipe, though we have had no way in which to compare the relative resisting qualities of the two pipes to electrolytic action.

While not committing myself in future work, believing that every separate plant should have intelligent study, and believing that the selection of the proper materials to be used in the construction of a water plant depends largely on local conditions, the writer is free to say, from his twenty-six years' experience with steel pipe, that it has been very satisfactory in Butte and other communities in Montana with which he is familiar. He does not hesitate to recommend it for water works, and in designing a new system would take into consideration more particularly the first cost of installation, cost of maintenance, repairs and operation in deciding between the use of steel or cast iron.

MATHESON JOINT STEEL WATER MAINS.

BY F. N. SPELLER.*

[*Read September, 1917.*]

For about thirty years welded steel bell and spigot pipe has been used for water mains. For the past ten years most of this has been made with the expanded end known as the Matheson Joint. Failures of the kind reported every week or so in the newspapers with cast iron have so far been practically unheard of with this kind of pipe. This unbroken record of reliability is not affected by occasional leaks due to severe corrosion or electrolysis or collar leaks which occur also in cast iron or other pipe. Reliability in service is based on the large and uniform factor of safety, especially against shock which obtains in this class of steel pipe. There are none of the hidden blowholes and other defects to be expected in cast metal. The foundation does not have to be so rigid. More power can be safely employed in calking and a much wider range of pressure can be safely carried in the same pipe compared with cast iron. Instances have been reported where this pipe has been permanently dinted and distorted by rock slides without leaking or interrupting service. For these reasons, and considering the large saving in weight, it is not surprising that Matheson Joint steel pipe has become so generally used in the mountain districts.

Each length of this pipe has a suddenly applied test pressure of 450 to 600 lb. at the mill. This, together with the strain which is put on the weld and material when the bell is rolled out, makes it almost a certainty that there will be no failures in service.

Carrying Capacity. Several tests have been run in service where cast iron and welded steel lines were conveniently located for this purpose, which proved the larger carrying capacity of the latter.† This has been carefully determined on new pipe (4-, 6-, and 8-in.) in some elaborate tests under the supervision of the Underwriters' Laboratory, the results of which will be published in the near future. These tests indicate an increase in capacity of 20 per cent. in the steel over cast iron of the *same*

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* Metallurgical Engineer, Pittsburg, Pa.

† *Engineering News*. November 9, 1916. Report on Glenwood Springs System, Colorado.

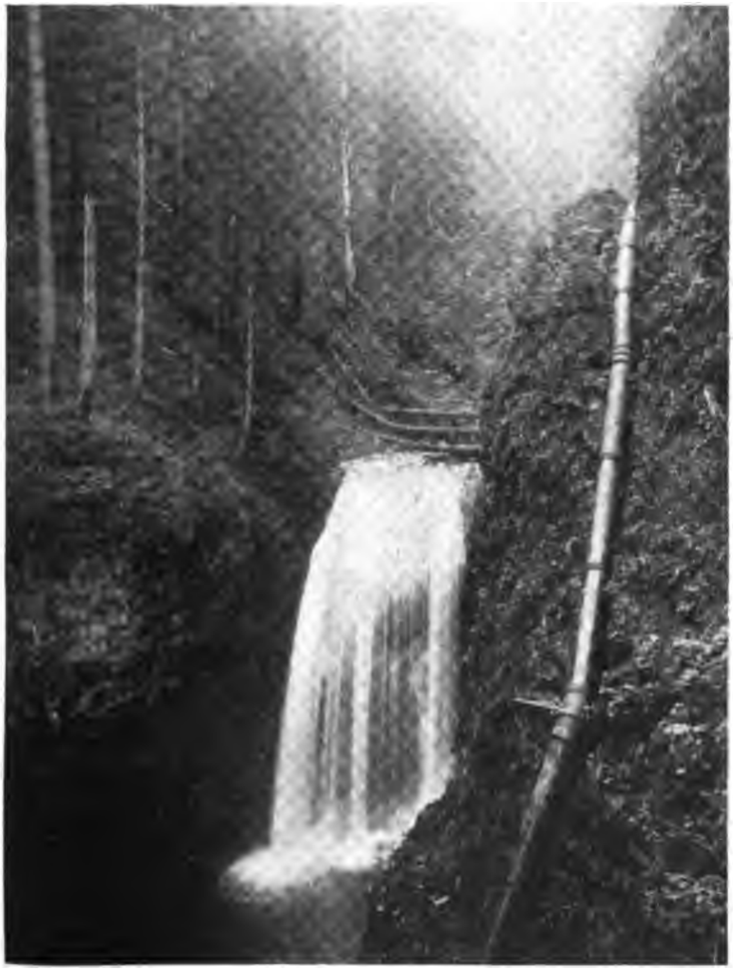

Fig. 1. An Example of the Value of "National" Matheson Joint Pipe Laid in a Country where Road Construction was Impossible, and the Pipe was carried by Aerial Cable to Otherwise Inaccessible Points.

inside diameter. As Matheson Joint steel pipe is made to O. D. and cast iron to I. D., the difference in favor of the steel on these nominal sizes is found to be 3 to 4 per cent.

Durability. The service records covering the past thirty years

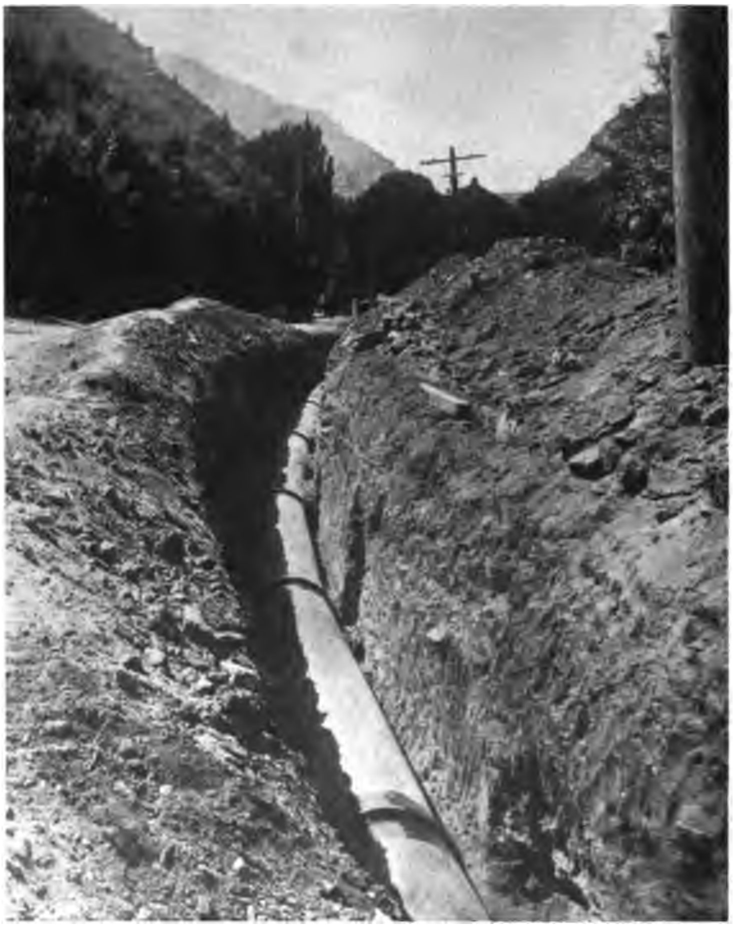

FIG. 2. SECTION OF A LINE OF 17 250 FEET OF 24-INCH O. D. "NATIONAL" MATHESON JOINT PIPE INSTALLED BY A CITY IN NORTHERN UTAH (OGDEN) THREE DEGREES PER LENGTH.

also indicates less tuberculation on steel, although this trouble, like corrosion, varies so much with water conditions that it is difficult to make close comparisons. Durability is usually discussed in conjunction with strength and reliability in service when, as a matter of fact, they are separate problems which involve materials having widely different properties. Cast iron is

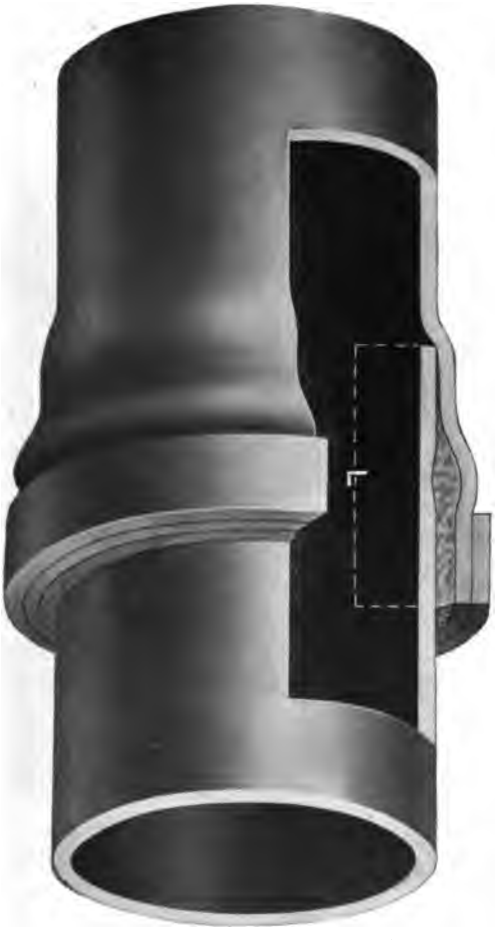

FIG. 3. "NATIONAL" MATHESON JOINT — SECTIONAL VIEW.

necessarily made comparatively thick on account of the weakness of the metal and limitations of casting operations.

To take advantage of the lighter weight and greater strength of steel, and at the same time increase the durability in service, involves the use of a reliable protective coating. Much has been done along this line of late years, led by the demands of the oil and gas interests, where high pressure and consideration for safety have made welded steel pipe the standard.

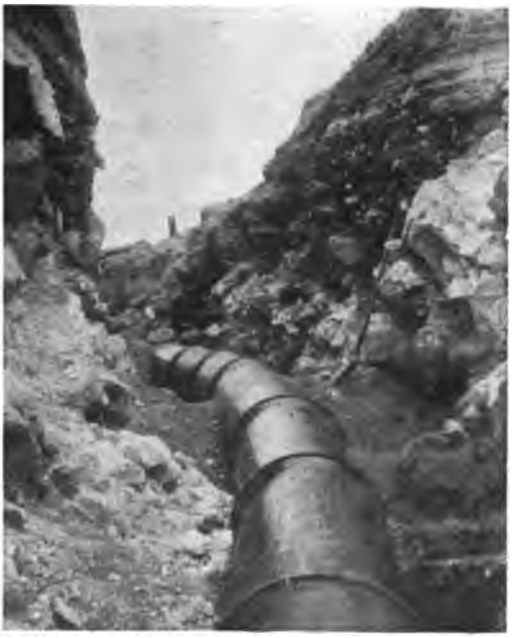

FIG. 4. CURVATURE ABOUT 50 DEGREES PER 100 FEET. DEFLECTION IS MADE BY FIVE-FOOT LENGTHS.

Where conditions are very bad, as in tidewater swamps, permanent protection has been obtained by boxing the pipe and filling in with two inches of well-mixed concrete. While this has been proved satisfactory by twenty years' experience, a cheaper and more flexible coating is usually all that is required.

Before any coating is decided upon, however, a careful survey of local conditions should be made to determine how much bad strata the pipe will pass through. It usually turns out that only five or ten per cent. of the system is exposed to conditions which might cause apprehension, and such localities may be carefully protected without involving a considerable expense per foot over the whole line. However, it is safe to say that some protection should always be provided underground. This may be only a dip outside and inside in hot asphaltum of good quality. This acts as a good priming coat should it be thought advisable to add further protection. We advocate a wrapping of fabric saturated with a good quality asphalt pitch having a flow point of about 150 degrees F. Another layer may be applied if necessary.

Special machinery has been designed to apply this coating tightly and uniformly at the place of manufacture, but if conditions warrant, the coating may be applied in the field after cleaning and drying the line and applying a thin priming coat such as coal tar dissolved in benzol. The Standard Oil Company of California applies two layers of asphalt of high melting point to the cold pipe as soon as the priming coat is dry, which is covered spirally with a strip of burlap about eight inches wide. Another thin coating should be applied to saturate and preserve the burlap. The writer has seen lines where the coatings so applied were $\frac{1}{4}$-in. thick on top and $\frac{5}{16}$-in. underneath. These oil lines operate at 700 to 800 lb. pressure. This would seem to be approaching the ideal system, where the pipe is strong and ductile enough to stand any reasonable amount of settlement or shock and where the coating is made of the material which experience has taught to be the best to withstand soil corrosion and electrolysis.

Inside corrosion of water mains has given comparatively little trouble; a properly applied dip has given all the protection required in the large majority of cases.

A SMALL WATER WORKS TESTING LABORATORY.

BY A. N. FRENCH, SUPERINTENDENT OF WATER WORKS, SENECA FALLS, N. Y.

[*Read November 14, 1917.*]

Within the last year or two water-works men have often had their attention called to the fact that there are many small filtering plants which do not have chemical laboratories, which do not make tests of the quality of the water, and which are in general operated without proper supervision. One of the latest papers of that sort which I have noticed is from the pen of Mr. Ray C. Werner, chemist of the Georgia State Board of Health. He urges that every water works which has a filtering plant should have a suitable laboratory for the purpose of making tests of the water and counting the bacteria.

I imagine that most water-works men realize the desirability of a laboratory, but they regard such a thing as beyond their financial means; as requiring much special education; and as, in general, something unattainable. In order to illustrate that it is not so very difficult or costly for a small water works to set up a laboratory, and that it is within the ability of almost every superintendent or chief engineer of a pumping station to gain the necessary knowledge in order to operate it, perhaps the experience of my company, and that of the chief engineer and myself, may be of interest.

The water supply for Seneca Falls, N. Y., comes from Cayuga Lake, one of the " Finger Lakes " of Central New York. Cayuga Lake is forty miles long; its depth reaches 410 ft., and its width varies from one mile to five miles. Its drainage area is mostly a farming country. The land is nearly all under cultivation, there being almost no forest land or waste land. The largest place on the lake is Ithaca, forty miles from Seneca Falls, and with a population of about 16,000. There are several small villages of a thousand or two or less, and the rest is farming country.

The waters of these Finger Lakes, like those of the Great Lakes, are naturally pure and fine, and in some instances are still so. The city of Rochester takes its domestic supply from Hemlock Lake without filtration or chlorination. The village of Penn Yan, which has some five thousand population, takes its supply from Keuka Lake without any sort of treatment. The city of Syracuse treats the water of Skaneateles Lake with chlorine. The city of Geneva has filters; and the city of Auburn is constructing a plant.

The state analyses of the water of Cayuga Lake at times indicate the presence of B. coli, and in times of freshet there is considerable turbidity. Our company installed rapid sand filters which were put into operation in the spring of 1913. The chief engineer and myself very soon felt that we were working in the dark, and set about accumulating knowledge necessary for the establishment and management of a small testing laboratory. We visited the cities near us which had filtering plants, and we bought books, and read and studied. We got more help from a book put out by the American Public Health Association, " Standard Methods of Water Analysis," than from any other book we had access to.

We were fortunate, at this stage, to bethink ourselves of the State Experiment Station at Geneva. We went there and made the acquaintance of Dr. Breed, bacteriologist, who gave us a great deal of help in the way of information and advice. Later he sent us a young man who was associated with him, and who had some experience in water analysis, and who made up for us a list of apparatus and chemicals necessary. After we got our apparatus and supplies, he came and stayed a few days with the chief engineer, and saw him started in the right way.

We partitioned off a small room in one corner of the upper floor of our filter building, built a bench, and made provision for the storage of our chemicals and apparatus — a matter of some cupboards and shelving.

We bought chemicals, glass ware, scales, magnifying glass, etc., of the Bausch & Lomb Company at Rochester. The larger pieces of apparatus are the most costly, and the purchase of them is the heavy financial item in setting up a laboratory; but, thanks to suggestions of Dr. Breed, we got over that part quite cheaply. For instance, instead of purchasing an expensive incubator we bought the smallest size of chicken incubator, costing us about seven dollars. For a hot-air sterilizer we bought a kerosene-oil stove and oven. We made our own autoclave from a piece of 8-in. steam pipe, and heated it with steam from our boilers. So that those expensive items of apparatus, which would have cost a good deal if bought of a maker of bacteriological apparatus, with us represented very little money.

With a moderate amount of traveling about, a small expenditure of money, — totaling, as I recall, around one hundred dollars, — and with a good deal of reading and study, we are now equipped and able to make the presumptive test for B. coli, the bacterial count, the test for alkalinity, and the test for free alum.

We have been making tests regularly for over two years now, and keeping a record of the results; and it is a lot of satisfaction to be able to do so. Of course our main reliance is on the fermentation test for gas-forming bacteria and the bacterial count. We make those two tests once a month. Our lake is so large, and its water is so constant in quality, that we do not feel it necessary to make more frequent tests. We have never had any gas formers in our filtered water, and often there are none in the raw lake water. The bacterial count in the raw water is not high either, except in time of freshets. Often it will be as low as 25 per c.c., but in time of flood it will run up to several hundred. In the filtered water our counts run as low as 5 per c.c. and as high as 40. We make our bacterial counts on agar, using the regular petri dishes.

The alkalinity test is not made very often. The lake water is about 80 or above, as a general thing, and, as we use only one-half grain or less of sulphate of alumina per gallon, we have such a margin of safety in alkalinity that we are safe, except in time of flood, when it will go down to zero, or nearly so, for a few days. Then is when we want to test for alkalinity, and if we could not do it, we would be unable to understand why our filters "did not work right," or know what to do.

Another satisfaction which we have had from our laboratory has been our ability to make tests on the wells about the village. This country is a clay-soil country, and in time of floods much turbidity gets into our lake. Consequently all of the older houses had their own wells. People did not like to drink roily water, and from a well they can almost always get clear water. Also there is much vegetation growing in our end of Cayuga Lake, and the lake water always tastes and smells of it. We have found, by testing wells scattered over the village, that most of them contained gas-forming bacteria, and the total count was high. By carefully disseminating that information we have cut down the use of well water largely. Every year sees a fewer number of wells in use. The filtering of our water keeps the sediment out of it, the bacterial count low, and removes most of the vegetable smell and taste, so that our people are losing their prejudice against it.

We would not be without our little laboratory for many times what it cost, and our experience leads me to think that almost any superintendent of water works or chief engineer of pumping station can have such a laboratory if he wishes, and make regular tests of the water. The cost is not prohibitive, and the necessary knowledge can be obtained.

DISCUSSION.

MR. ROBERT SPURR WESTON. I think this paper is along a very good line, and one that is well worthy of attention. Many plants which are designed by the best engineers have not worked properly because, after the end of the contract period, the engineer has had no further control of the plant, and the water has been over-treated or under-treated, the filter bed has not been taken care of, or some other accident has happened, which has given the plant a bad name. As a result the engineer very often gets blamed for what is not his fault. Therefore this paper ought to be emphasized as a step along the right path.

Water purification plants may perhaps be grouped in three or four classes. The first class includes those where the water works employs a chemist all the time. This does not cost less than $2 000 a year for a first-class man, with equipment, supplies and everything, and that expenditure, of course, is possible only in the larger works. I think about $3.00 per 1 000 000 gal. is about the limit that any works can pay for this sort of supervision. That would mean $329 a year for a small works, producing 300 000 gal. a day.

The second class is where the local engineer or superintendent himself makes the tests for turbidity, alkalinity, and so forth, and then some central laboratory, state or private, makes monthly or bi-monthly or quarterly analyses. This is a very efficient way of controlling plants, especially small ones.

Then, again, there is the third grade of supervision, where there is no works laboratory, but where a central laboratory makes an inspection every month. That is the kind of supervision which all of our Massachusetts plants get, and this is the minimum which any purification plant ought to get.

Then the fourth grade, of course, is where there is no laboratory supervision at all.

One difficulty in the way of establishing a laboratory in a small works is that all pumping-station men are not adapted by training to acquire the methods of bacteriological specialists. I know of one water works, however, a few miles north of Boston, which has a very intelligent engineer who makes some of the most complicated tests with a very great degree of accuracy; and we happen to have under our supervision other plants where no amount of teaching by a most competent man would get those in charge to grasp ordinary routine tests and make them with any degree of accuracy. So I think the personal element has always to be taken into consideration. But, generally speaking, I think it is a most important part of water-works management to have some sort of laboratory control over filter plants.

President Saville. There is one matter that neither Mr. Weston nor Mr. French has mentioned, which is of considerable importance, not from the financial but from the management end, and that is the difficulty, especially in municipal plants, of getting a man who will stay with you for the money which you can pay. It takes some time to break a man in. You get a young man from Mr. Weston's laboratory, perhaps, or from some other good laboratory, or one who has had a few years' experience with the State Board of Health, and is anxious to get out and is willing to go to work for a small salary. You put up with a good many things with him for a year or so, and get him in pretty good shape, and then he begins to be uneasy. He has become a valuable man and he wants more money. The high cost of living hits him, but the " powers that be " don't want to furnish the money to pay him any more, and then you have to begin all over again. It is a pretty difficult thing for a small laboratory to get a competent man and keep him for any length of time. I think Mr. Weston will bear me out in that.

REPORT OF COMMITTEE ON REVISION OF STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS.

The Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings begs to submit the following report.

This committee, appointed in 1912, has for several years coöperated with a similar committee of the American Water Works Association, which latter committee at the Richmond Convention in May, 1917, submitted to its parent body a report which may properly be said to be the joint work of the committees of the two associations. We cannot improve on that report, and therefore beg to submit it for your careful consideration:

The Committee on Revision of Standard Specifications for Cast-Iron Water Pipes and Special Castings begs to submit the following report:

Appointed in 1911, this committee has for several years coöperated with a similar committee of the New England Water Works Association.

In January, 1916, at a joint meeting, held in New York City, a joint committee of six members — three from the committees of each association — was appointed to prepare a tentative draft of revised specifications, to be submitted to the manufacturers for their examination and criticism. The resulting draft was forwarded to the manufacturers on May 6, 1916, accompanied by the following letter:

To the Manufacturers of Cast-Iron Pipe:

The enclosed specifications for Cast-Iron Water Pipe and Fittings, prepared by a joint committee formed from the committees of the American and New England Water Works Associations, is a preliminary draft of proposed new Standard Specifications, and is sent you for your criticism and discussion.

It is the intention of the joint committee to hold a meeting in New York City within a few months, and to invite manufacturers to appear and present in person their discussion of the enclosed specifications, or, if attendance is not possible, to submit such discussion in writing at this meeting, notice of the time of which will be given thirty days in advance of the date finally chosen.

For your information, a brief statement of the development of the specifications now sent you may be of interest. In June, 1911, the American Water

Works Association appointed a committee to revise the existing Standard Specifications for Cast-Iron Pipe, and in March, 1912, the New England Water Works Association appointed a committee for a similar purpose. Both committees at once appreciated the fact that the first object in the work should be the development of a single specification, acceptable to both associations, and which, it might be hoped, would later be adopted by all other societies and therefore become, in fact, a standard specification.

While many independent meetings of the two committees have been held during the past three years, much of the time of each committee has been spent in considering suggestions and questions submitted by the other, and January 21, 1916, a joint meeting of the committees was held in New York City, an entire day being devoted to the discussion of the modifications and revision of a tentative specification which the two committees had been considering for a number of months past. At this meeting, it was voted that a joint committee, of six members — three from the committee of each association — prepare a tentative draft of specifications to be sent to manufacturers for their discussion and criticism; and the specification now forwarded to you is the result of the work of this joint committee.

In submitting this draft of specifications for your examination, it may further be well to state that the committee recognize that the proposed specifications will involve some increase in the cost of production, but it is believed that the resulting advantages to users will be sufficient to make the slight increase in cost of no practical moment. It is therefore hoped that the manufacturers will approach the consideration of these specifications on the assumption that there is a substantial demand for a uniform outside diameter, and good reasons for a specification of the chemical character of the metal, for the relation between flexure and breaking load, and for an improved coating.

It is to be understood, however, that the present draft is altogether tentative, that the minds of the committee are open, and that this draft is now sent you for your discussion and criticism, with the hope that finally a standard specification may be developed, acceptable throughout this continent, at least, to the users and to the manufacturers of the pipe, and which will become effective at such time in the future as will reasonably allow for any necessary changes in foundry equipment.

JOINT COMMITTEE.

JOHN H. GREGORY,	FRANK A. MCINNES,
N. F. S. RUSSELL,	FRANK A. BARBOUR,
WALTER WOOD,	W. R. CONARD,
Am. W. W. Assoc.	N. E. W. W. Assoc.

May 7, 1916.

On November 23, 1916, an invitation was sent to the manufacturers to meet the Joint Committee in New York on December 14, 1916, of which the following is a copy:

Dear Sirs, — In May, 1916, a copy of a Tentative Draft of Standard Specifications for Cast-Iron Pipe and Fittings, proposed by the Joint Committee of the American and New England Water Works Associations, was sent you for your examination and criticism. In the accompanying letter it was stated that a meeting, to be held in New York City, would be called at some future date, which it was hoped you would attend and present to the committee your views regarding the proposed specifications.

We now beg to advise you that this meeting will be held in the House of the American Society of Civil Engineers, No. 220 West 57th Street, New York City, at ten o'clock A.M., on Thursday, December 14, 1916, and we earnestly desire that you arrange to attend and be prepared to discuss the proposed specification.

The draft already sent you is altogether tentative, and any amendments or suggestions you may care to make will be given due consideration.

Yours truly,

FRANK A. McINNES, *Chairman,*
New England Water Works Assoc.
Committee.

JOHN H. GREGORY, *Chairman,*
American Water Works Assoc.
Committee.

November 23, 1916.

At the meeting held on December 14, 1916, which was presided over by Mr. Leonard Metcalf, President of the American Water Works Association, there were present, in addition to the presiding officer, the following:

Representatives of the New England Water Works Association: Frank Barbour, Wm. R. Conard, Thomas H. Wiggin.

Representatives of the American Water Works Association: John H. Gregory, Frank A. Barbour, W. H. Randall, N. F. S. Russell, Walter Wood.

Representatives of manufacturers: N. F. S. Russell, U. S. C. I. Pipe and Foundry Company; Walter Wood, R. D. Wood & Co.; S. B. Brown, Warren Foundry Company; S. H. Morrison, Warren Foundry Company; R. W. Conrow, Central Foundry Company; R. R. Rust, Central Foundry Company.

The important changes from the present standard specifications proposed by the Tentative Draft of Revised Specifications, and which were the subject of discussion in the meeting of December 14, 1916, are as follows:

1. The adoption of a uniform outside diameter for all classes of pipe of the same size.
2. The specification of the permissible range of total carbon, combined carbon, silicon, manganese, phosphorus, and sulphur in the metal.
3. The requirement of a relation between flexure and breaking load in test bars.

Other less important revisions included more complete specification for coating, the including of the element of time in the hydrostatic test requirements, the addition of flanged pipe and the substitution of the word "fittings" for special castings.

After a prolonged discussion of the proposal to adopt a uniform outside diameter and of the feasibility of specifying chemical quality of the metal, — the stenographic report of which covers 128 typewritten pages, — it became evident that the manufacturers, as represented at the meeting, were opposed to the revision of the present specifications, for various reasons, including the expense incident to changes in present equipment, increased manufacturing difficulties, and the belief that the present specifications were good enough.

In order that the statements of the manufacturers as to the effect of the proposed changes on cost of production and on the technique of manufacturing might be supported by definite figures and arguments, the following motion was unanimously carried:

> Moved that the manufacturers be requested to consider the tentative specifications for cast-iron pipe as prepared and submitted to the manufacturers under date of May 7, 1916, and report to the committee at a meeting to be held on March 15, 1917, the result of their deliberations, with such modifications of the specifications, paragraph by paragraph, as may seem to them desirable, together with their reasons therefor.

It was the understanding of those present that the manufacturers would discuss in detail the tentative revised specifications, and would present in writing at the meeting to be held on March 15, 1917, the results of their deliberations.

When the date of this meeting approached, it was found that the manufacturers were not prepared to submit any detailed discussion of the tentative draft of specifications, and on March 31 the following letter was received by the chairman of your committee:

JOHN H. GREGORY, *Chairman, Committee on Cast-Iron Pipe Specifications, American Water Works Association, 170 Broadway, New York City:*

Dear Sir, — Referring to the request of the committee that the manufacturers should again study the tentative specifications submitted by the joint committee of the American Water Works and New England Water Works Associations, and if necessary to propose their own specifications:

We beg to state that this question has been fully discussed at three meetings of the manufacturers, and it is the unanimous opinion that there are no essential changes, at the present, necessary in the specifications of the American Water Works Association, adopted May 12, 1908.

These specifications are not ideal, but, for practically ten years, have proven fairly satisfactory to both user and manufacturer, as evidenced by their almost universal adoption.

We would, therefore, respectfully suggest that the Specifications of the American Water Works Association, as now drafted, remain unchanged.

Yours very truly,
(Signed) WALTER WOOD,
N. F. S. RUSSELL.

The preceding letter makes evident the position of the manufacturers and the fact that not only will they not agree to any changes in the present specifications until forced to do so by the demand of consumers, but they will not coöperate with your committee to the extent of furnishing detailed reasons and figures in support of their objections to the proposed revision. Under these circumstances the only course open to your committee is to submit to the membership the tentative draft of revised specifications, and to request that after a reasonable time a ballot be taken to determine whether the Association is in favor of the adoption of the important changes suggested by these revised specifications, viz., a uniform outside diameter, chemical requirements of the metal, and a relation between flexure and breaking load.

To this end we recommend that the tentative draft of the revised specifications be printed and distributed to the members. The present draft of revised specifications is submitted to the Association for the purpose of ascertaining whether your committee is working along lines approved by the membership, and there will doubtless be material modification in the present draft before final form is reached. It is not proposed that after final adoption the new specifications should go into effect for a number of years.

Presumably the New England Water Works Committee will follow the same course as suggested in this report, and will submit the revised specifications to that Association for its consideration.

It is obvious that in view of the manufacturers' dictum that the present specifications are good enough, any further work on the part of your committee must be determined by the action of the Association. Presumably there was some reason for the appointment of this committee, and if, in the judgment of the Association, there still remains sufficient reason for a revision of the specifications, doubtless the manufacturers will meet any reasonable requirements which may be demanded, but it is to be pointed out that all members should give serious consideration to the proposed revision, and should be prepared to follow up any vote in favor of revising the present specifications by a determination to use only the revised specifications in their future work. It is believed that if, by coöperation with the New England Water Works Association and other similar bodies, a single standard specification can be developed, the result will be to the advantage of all concerned, including both the users and the manufacturers.

Respectfully submitted,

JOHN H. GREGORY, *Chairman.*
EDWARD E. WALL.
W. H. RANDALL.
F. A. BARBOUR.

May 11, 1917.

The only course open to your committee is to follow the action recommended in the above report.

It is therefore recommended that the tentative draft of specifications, and the report of the committee of the American Water Works Association, be printed and distributed to the members; that, at the next monthly meeting after such distribution, the subject be thrown open for discussion and that during the month following this discussion a Questionnaire be sent out, reading, in general terms, as follows:

With the understanding that no change will be made in the Standard Specifications for Cast-Iron Pipe and Special Castings until after *the present world war has ended, and not then until after a reasonable period has elapsed for the manufacturers to revise their equipment:*

Are you in favor of the adoption of a uniform outside diameter?
Are you in favor of chemical requirements of the metal?
Are you in favor of a relation between flexure and breaking load?

It may appear advisable, after the suggested meeting for the discussion of the Revision of the Specifications, to change the above outlined series of questions, but, however this may be, the object of the Questionnaire is to obtain from the membership a mandate which will either justify the committee in continuing its work or make it evident that our Association does not desire Revised Specifications.

F. A. McInnes, *Chairman.*
F. A. Barbour.
W. R. Conard.
G. A. King.
T. H. Wiggin.

TENTATIVE DRAFT OF STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND FITTINGS, PREPARED BY JOINT COMMITTEE OF THE AMERICAN AND NEW ENGLAND WATER WORKS ASSOCIATIONS.

(Changes from present New England and American specifications are in *italics*.)

DESCRIPTION OF PIPE.

SECTION 1. The pipes shall be made with *bell* and spigot *ends or with flange ends*, and shall *conform accurately* to the dimensions given in Tables Nos.   and   . They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter.

Bell and spigot pipes shall be at least 12 ft. in laying length, exclusive of the bell, and flange pipes shall be at least 12 ft. in length face to face of flanges.

All classes of pipe of each size shall have the same outside diameter. All pipes having the same outside diameter shall have the same inside diameter at both ends.

The inside diameter of the lighter pipes of each standard outside diameter shall be gradually increased for a distance of about 6 in. from each end of the pipe barrel, so as to obtain the required standard thickness and weight for each size and class of pipe.

DESCRIPTION OF FITTINGS.

SECTION 2. *There shall be two types of standard fittings, known as "Bell Fittings" and "Flange Fittings." Fittings having bell or spigot ends, or both, but no flange end or ends, shall be known as "Bell Fittings." Fittings having one or more flange ends shall be known as "Flange Fittings."*

All fittings shall be made in accordance with the cuts and dimensions given in the tables forming a part of these specifications. They shall be true circles in section with their inner and outer surfaces concentric on both run and outlet, except where intersections prevent. On all fittings the outside diameter of the barrel on each outlet shall be the same as the outside diameter of the pipe of corresponding size.

For pipes from 4 to 20 in. in diameter, inclusive, one class of fittings known as Class D fittings shall be furnished for all classes of pipe. For pipes over 20 in. in diameter, two classes of fittings, known respectively as Class AB and CD fittings, shall be furnished, Class AB fittings for Class A and Class B pipes, and Class CD fittings for Class C and Class D pipes.

Any fitting not shown in the tables hereto attached shall be known as a "Special Fitting."

VARIATION IN DIAMETER OF BELLS AND SPIGOTS.

SECTION 3. Especial care shall be taken to have the *bells* and spigots of the required size. The *bells* and spigots will be tested by circular gages, and no pipe *or fitting* will be accepted *which, for any cause, does not comply with the specified joint space, except as hereinafter allowed.*

The inside diameters of the bells and the outside diameters of the spigot ends of pipes shall not vary from the standard dimensions by more than 0.06 in. for pipes 16 in. or less in diameter; 0.08 in. for pipes 18, 20 and 24 in. in diameter; 0.10 in. for pipes 30, 36 and 42 in. in diameter; 0.13 in. for pipes 48, 54 and 60 in. in diameter; *and 0.18 in. for pipes 72 and 84 in. in diameter.*

The inside diameters of the bells and the outside diameters of the spigot ends of the fittings shall not vary from the standard dimensions by more then 0.08 in. for fittings 16 in. or less in diameter; 0.10 in. for 18-, 20-, and 24-, in. fittings; 0.13 in. for 30-, 36-, and 42-in. fittings; 0.16 in. for 48-, 54- and 60-in. fittings; and 0.20 in. for 72- and 84-in. fittings.

VARIATION IN THICKNESS.

SECTION 4. For pipes whose standard thickness is less than 1 in. the thickness of metal in the body of the pipe *shall not vary more than* 0.08 in. from the standard thickness, and for pipes whose standard thickness is 1 in. or more, the variation shall not exceed 0.10 in., except that for spaces *the length across which in any direction does not exceed 8 in., a decreased thickness not exceeding 0.02 in. will be permitted, and for spaces the length across which does not exceed 16 in. in any direction, an increased thickness not exceeding 0.05 in. will be permitted* — both in excess of the allowances above stated.

For fittings, a variation 50% greater than that allowed for pipes shall be permitted.

ALLOWABLE PERCENTAGE OF VARIATION IN WEIGHT.

SECTION 5. No pipe shall be accepted, the weight of which shall be less than the standard weight by more than 5 per cent. for pipes 16 in. or less in diameter and 4 per cent. for pipes more than 16 in. in diameter, and no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. The total weight of pipe to be paid for shall not exceed, for each size and class of pipe received, the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 2 per cent.

No *fitting* shall be accepted, the weight of which shall be less than the standard by more than 10 per cent. for *fittings* 12 in. or less in diameter and 8 per cent. for larger sizes (except that curves and Y-branches may be 12 per cent. below the standard weight); no excess above the standard weight of more than the above given percentages for the several sizes shall be paid for. *The total weight of fittings to be paid for shall not exceed the sum of the standard weights of the same number of pieces of the given sizes and classes by more than 5 per cent.*

QUALITY OF IRON.

SECTION 6. All pipes and fittings shall be made of cast iron of good quality and of such character as shall make the metal of the casting strong, tough, and of even grain, and soft enough satisfactorily to admit of drilling and cutting. The metal shall be made without *the admixture of any inferior material*, and shall be remelted in cupola or air furnace.

The contractor shall furnish the engineer with copies of the mill *analyses of each heat or run of metal, and shall furnish samples to the engineer for check analyses when required.*

The metal for the pipes and fittings shall fulfill the following chemical requirements: Total carbon, 3 to 3.75 per cent.; combined carbon, 0.5 to 0.75; silicon, 1.6 to 2; manganese, 0.35 to 0.55; phosphorus, not to exceed 0.90; sulphur, not to exceed 0.10 per cent.

TESTS OF MATERIAL.

SECTION 7. Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made, without charge, as often as the engineer may direct, and in default of definite instructions the contractor shall make and test at least one bar from each heat or run of metal. The bars, when placed flatwise upon supports 24 in. apart and loaded in the center, shall support a load of 2 000 lb., and show a reflection of not less than *0.32 in. before breaking, and an increase in deflection of not less than 0.03 in. for each 200 lb. of ultimate breaking load in excess of 2 000 lb.*

The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

CASTING OF PIPE.

SECTION 8. The pipes shall be cast in dry sand molds in a vertical position. Pipes 16 in. or less in diameter *may* be cast with the *bell* end up or down, unless *otherwise* specified *by the purchaser.* Pipes 18 in. or more in diameter shall be cast with the bell end down.

The pipes shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent contraction by subsequent exposure.

QUALITY OF CASTINGS.

SECTION 9. The pipes and fittings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which, in the opinion of the engineer, unfit them for the use for which they are intended. No plugging or filling will be allowed.

MARKING.

SECTION 10. *Each* pipe and *fitting* shall have distinctly cast upon it the initials of the maker's name, a *letter designating the class to which the casting belongs, and figures showing the year in which it was cast. When cast to order, if required by the purchaser, each pipe and fitting 6 in. or more in diameter shall also have cast upon it a serial number, designating the order in point of time in which it was cast, the serial number to be placed below the date, thus:*

1916 1916 1916
1 2 3

etc., and any initials, not exceeding four, *or a symbol,* which may be required.

The letters and figures shall be cast on the outside, and shall *be not* less than 2 in. in length and ⅛ in. in relief for pipes *and fittings 10 in.* in diameter and larger. For smaller sizes of pipe, the letters may be 1 in. in length. The weight, *serial number,* and class letter shall be conspicuously painted in white on the inside of each pipe and *fitting* after the coating has become hard.

DEFECTIVE SPIGOT ENDS MAY BE CUT

SECTION 11. Defective spigot ends on pipes 12 in. or more in diameter may be cut off in a lathe, and a half-round wrought-iron or *mild-steel* band, shrunk into a groove, cut at the end of the pipe. Not more than 12 per cent. of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 ft. in length, exclusive of socket.

Pipes may be cast with shrink-head above spigot bead, and such pipe shall not be considered as cut pipe in determining the percentage above referred to.

In case the length of a pipe differs from 12 ft., the standard weight of the pipe given in Table — shall be modified in accordance therewith.

FLANGES.

SECTION 12. *Flanges shall be cast solid and shall be accurately faced smooth and true. Holes for bolts or studs shall be drilled, and the flanges shall be tapped where required. The contractor shall* *furnish and deliver all bolts and nuts for bolting on manhole covers. The bolts and nuts shall be of the best-quality wrought iron or mild steel, with good, sound, well-fitting threads, the nuts to be cold punched. The heads and nuts shall be hexagonal and shall be trimmed and chamfered. The heads, nuts and threads shall be of the United States Standard sizes.*

CLEANING AND INSPECTION.

SECTION 13. All pipes and *fittings* shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the *engineer* immediately before being *coated.*

COATING.

SECTION 14. Every pipe and *fitting* shall be coated inside and out with coal-tar pitch varnish. *Each pipe and fitting shall be heated to a uniform temperature of 320 degrees F., in a suitable oven, before it is dipped, and the material in the tank shall also be maintained at this temperature, and each pipe and fitting shall be kept in the bath for at least five minutes, during which time the temperature of all parts of the bath, including the bottom, shall be as specified.*

After removing the pipe from the bath, it shall be suspended or set in a vertical position until the coating has solidified.

The coating shall be of pitch, made from coal tar, distilled until the naphtha is removed, and sufficient oil to make a smooth coating, tough, elastic, strongly adhesive to the metal, tough and tenacious when cold, and not brittle nor with any tendency to scale off. Coating shall not be soft enough to flow when exposed to summer heat, nor brittle enough to crack and scale when exposed to a temperature below freezing

The pitch shall be straight-run, coal-tar pitch, which shall soften at 60 degrees F., and melt at 100 degrees F., being a grade in which distillate oils, distilled therefrom, shall have a specific gravity of 1.05. The pitch shall not contain less than 10 per cent. nor more than 18 per cent. of free carbon.

Fresh pitch and oil shall be added to the tank when necessary to keep the mixture of the proper consistency. The oil used for this purpose shall consist of heavy, coal-tar oil, with a specific gravity of *not less than 1.04 at 60 degrees F., and which shall not lose more than 5 per cent. of oil when distilled up to 400 degrees F.; not more than 40 per cent. of oil when distilled up to 450 degrees F. If the material in the tank thickens or deteriorates when used, the tank shall be emptied of its contents and refilled with fresh material when deemed necessary by the engineer.*

Fittings which are too large to be immersed shall be coated with hot varnish by hand, the fittings to be heated as specified above and the coating applied immediately thereafter.

Faces of flanges and finished surfaces shall be coated with a mixture of grease and white lead immediately after they have been faced and drilled.

Any pipe or *fitting* that is to be recoated shall first be thoroughly scraped and cleaned.

HYDROSTATIC TEST.

SECTION 15. When the coating has become hard, the pipe shall be subjected to a proof by hydrostatic pressure, and, if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressures to which the different sizes and classes of pipe shall be subjected are as follows:

Class.	Hydrostatic Pressure Lb. per Sq. In. Diameter Less than 20 In.	Diameter 20 In. and Over.
A	300	150
B	300	200
C	300	250
D	300	300

The full hydrostatic pressure shall be applied to the pipes for one minute on pipes 12 in. and less in diameter; for two minutes on 14-, 16-, 18-, 20- and 24-in. pipes; for three minutes on 36-in. pipes; and for five minutes on pipes larger than 36 in. in diameter.

Fittings shall also be subjected to a proof by hydrostatic pressure, provided the same is specified in the contract. If tested, the hydrostatic pressures to which the fittings shall be subjected shall be the same as those to which pipes of the same size and class would be subjected, and shall be applied for the same length of time.

WEIGHING.

SECTION 16. The pipes and *fittings* shall be weighed for payment under the supervision of the engineer after *they have been coated.* If desired by the purchaser, the pipes and *fittings* shall be weighed after their delivery. The weight so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weigh master. *The cost of weighing after delivery shall be borne by the purchaser.*

Bids shall be submitted and final settlement made upon the basis of a ton of 2 000 lbs.

CONTRACTOR TO FURNISH MEN AND MATERIAL.

SECTION 17. The *contractor* shall provide all tools, testing machines, materials and men necessary for the required testing, inspection and weighing at the foundry of the pipes and *fittings,* and should the purchaser have no inspector at the *foundry,* the contractor shall, if required by the purchaser, furnish a sworn statement that all of the tests have been made as specified, this statement to contain the results of *the chemical and physical tests.*

POWER TO INSPECT.

SECTION 18. The engineer shall be at liberty at all times to inspect the material at the foundry and the molding, casting and coating of the pipes and *fittings.* The forms, sizes, uniformity and conditions of all pipes and *fittings* herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipe or *fitting* which is not in conformity with the specifications or drawings furnished.

INSPECTOR TO REPORT.

SECTION 19. The inspector at the foundry shall report daily to the contractor all pipes and *fittings rejected,* with the causes for rejection.

CASTINGS TO BE DELIVERED SOUND AND PERFECT.

SECTION 20. All pipes and *fittings shall* be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the contractor of any of his obligations in this respect, and defective pipes or *fittings* which may have passed the engineer at the foundry or elsewhere shall be at all times liable to rejection, when discovered, until the final completion and adjustment of the contract, provided, however, that the contractor shall not be held liable for pipes or *fittings* found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipes *and fittings* not to injure the coating, and no pipes, *fittings* or other material of any kind shall be placed in the pipes or *fittings* during transportation *or at* any time after they have *been coated.*

The contractor shall not be held responsible for any expenses or damages incurred in handling or using the castings after they have been accepted at the agreed point of delivery. Any pipe or fitting that proves defective shall, when requested, be replaced by the contractor, the measure of the damage not to exceed the value of the casting found defective. The contractor shall have the right to call for the defective casting to be returned to him at the agreed point of delivery before any allowance for the same is demanded.

DEFINITION OF THE WORD "ENGINEER."

SECTION 21. Wherever the word "engineer" is used herein, it shall be understood to mean the engineer or inspector acting for the purchaser, and his properly authorized agents, limited by the particular duties intrusted to them.

DISCUSSION ON REVISION OF REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS.

President Davis. We will proceed to the first business in order, and that is the matter of the report of the Committee on Standard Specifications for Cast-Iron Pipe. Mr. McInnes made a preliminary report at the last meeting. Mr. McInnes, are you prepared to go on with the report on the cast-iron pipe?

Mr. Frank A. McInnes. You are quite fully informed by the circular in regard to the reason for the discussion to-day, and I won't cover that ground. It is unfortunate that at least three of our members who took a prominent part in the conference with the manufacturers are absent, viz., Mr. Wiggin, Mr. Barbour, Mr. Gregory, I do not see. I see Mr. Conard, a member of our committee and a member of the joint committee who was present at the meeting in New York.

I regret that, due to the exigencies of the past couple of years, it has been impossible for me to attend any of the meetings.

A bone of contention has been the uniform diameter. There is, first of all, a serious question as to whether or not that is desirable. The manufacturers, as I understand it, are as a unit opposed to it; and perhaps it would be fair to say that they are opposing it on two grounds: First, that the cost would be prohibitive — and here again we have not yet found out what that cost would represent for a ton of output; and, secondly, the statement has been made, and I have no doubt it is honestly believed, and it may be a fact, that the majority of the users of pipe do not want the outside diameter. That, perhaps more than any other reason, is the cause of the action we have taken. No one would be more delighted to know the facts than the committee, and no one would more willingly give up an arduous job and stop. And we could see no better way than to ask all the members of our Association. I am very sure the manufacturers would welcome this information, as the committee would.

I do not intend to make an argument one way or the other to-day; will give my own experience. Take the chemical requirements, for instance. A number of broken pipe, perhaps a dozen, or possibly twenty, I have had analyses made, and in ninety per cent. the result showed conditions which any foundryman or user of pipe would at once say were bad. I realize fully that the chemical analysis only shows us what was in the pipe, and does not show us how the different elements were combined in the pipe; that the microscope only would show; and while I am convinced that the microscope is the ultimate solution of our problem, still I hope we may help things out by specifying a moderate, conservative chemical requirement.

And, again, the relation between flexure and breaking load. Whether or not it is enough to simply say that a pipe will break at 2 000 lb. with a deflection of three tenths of an inch. In our local work we get up against this condition a great many times, that it is necessary to go up to 2 400 lb. in order to get a deflection of three tenths of an inch; the result being iron which is very strong and very hard. We want to know whether that can be avoided or guarded against in the specifications.

It is not altogether unfair to say that we as a committee have come to a deadlock, in a sense, but we want to have you consult with us, and help us in every way possible. I know the manufacturers will be ready to do so. I have a letter just received from the president of one of our largest companies, and his concluding sentence is, — " I am sure the foundrymen want to be absolutely frank in the discussion of these specifications." I have not a doubt in the world that that is the condition, and represents the case exactly so far as the foundrymen are concerned.

I do not see that there would be much object in my going at length into this thing now. I want you to remember that if the revised specifications are adopted, there is no intention to put them into operation during the war, or during the period after the war necessary for readjustment.

Mr. President, I move that any foundrymen or makers of pipe, or others interested in producing pipe, be given the privilege of the floor in the discussion this afternoon.

(The motion was seconded and carried.)

President Davis. Now, then, in accordance with the motion, I will call on any manufacturers, makers, or others who are prepared to take part in this discussion. Possibly there may be some written discussions.

Mr. Charles R. Wood (of R. D. Wood & Co.). We should like to know just what is going to be done. What is going to happen now? We do not quite understand. Our firm is not ready to discuss them, but want to know what is to be the procedure. What do you expect to do with this tentative draft? Are you going to get up a questionnaire and hand it around to all the members?

President Davis. I take it that that is covered on the sixth page of the report of the committee, — near the top of the sixth page:

> " It is therefore recommended that the tentative draft of specifications, and the report of the committee of the American Water Works Association, be printed and distributed to the members; that, at the next monthly meeting after such distribution, the subject be thrown open for discussion, and that during the month following this discussion a questionnaire be sent out, reading, in general terms, as follows:
>
> " ' With the understanding that no change shall be made in the Standard Specifications for cast-iron pipe and special castings until after the present world war has ended, and not then until after a reasonable period has elapsed for the manufacturers to revise their equipment,
>
> " ' Are you in favor of the adoption of a uniform outside diameter?
> " ' Are you in favor of chemical requirements of the metal?
> " ' Are you in favor of a relation between flexure and breaking load? ' "

The reference there to " the next monthly meeting," means the meeting we are holding to-day. Now, I take it this meeting is one for general discussion, and the committee recommend that following this meeting a questionnaire be sent out covering additional points.

Mr. Wood. Then I should like to suggest that a representative of the manufacturers be given a chance to discuss with the committee the exact wording of that questionnaire, if the committee sees fit — of course if they do not want to, they don't have to, but I think it would be a very good thing. While the manufacturers may not have responded to the previous suggestions of the committee, I think they would be glad to suggest one or two questions they would like to ask.

The broad question the manufacturers want to know is, whether there is any demand for a change in the specifications. I think Mr. McInnes said he was not sure there was.

It may be of interest to say that we have just received a copy of the new standard British specifications, which they have adopted after ten or fifteen years' hard work. After the war is over we want to get specifications in this country that will enable us to go into the world market in competition with the British and German manufacturers; therefore, we suggest that any standard specifications in this country be drawn up with the idea of enabling us to compete with the foreign manufacturers in every country, as we are going to be more of an exporting nation than ever before after this war is over; that is one thing the manufacturers of pipe are very anxious to have the committee bear in mind. Whether there is anything in the specifications that we would object to, or would want to add, we would not like to have the matter pushed forward too fast. We would not wish the committee to delay action exactly, but we want to have it go slowly and carefully. If the questionnaire is going to be sent out, we should be glad if some one of the manufacturers could see a list of those questions before they were sent out. There may be something we could suggest that would be of value.

PRESIDENT DAVIS. Mr. McInnes, have you any comments to make on that suggestion?

MR. MCINNES. We are only trying, Mr. President, to find out what the manufacturers want to know. What they want to know, we want to know. I do not see what additions are necessary. A simple question will be given, and a very plain answer will be expected. And if the answer is adverse, then we stop as a committee; if it is favorable we will get up against our friends, the makers of pipe, again. And we certainly would not expect to go too fast.

There is one other thing which has come up very recently. That is as to whether the engineers in England have adopted the outside diameter. That is of importance and interest to us. I have written for a copy of the English specifications, but I have not received it.

I do not see why this questionnaire should be delayed.

Mr. Wood. Mr. President, it is not necessary to delay it, but we would like to make one or two suggestions about the questions which are to be asked. In other words, it will be very unfortunate if the manufacturers are forced to get out an elaborate pamphlet objecting to the specifications. And, if they go out as they are, the manufacturers will be forced to take that action, and send to every member of the New England and American Water Works Associations a statement of what will happen. We should not be put in that position. If we were allowed to put one or two questions in that questionnaire ourselves — or suggest one or two, rather, I think it will work out very easily.

Mr. McInnes. I am sure, as one, I should welcome a conference with them before we put out the questionnaire; but it must be entirely in our hands. If they can advise us in a way which we think worth while, we shall be glad to adopt the suggestions.

President Davis. Mr. McInnes said he would like to get the thought of the Association on that suggestion. Apparently, as I understand it, it is that if this questionnaire is sent out, that it be after a consultation with representatives of the manufacturers. Are there any suggestions or comments on that suggestion as made by Mr. Wood? As I understand it, — if there is no comment, nothing to be said on the matter, — the committee has the framing of the questionnaire in their hands; and all they are asking from this meeting to-day, as I understand the matter, is authority to send it out. Am I correct, Mr. McInnes?

Mr. McInnes. I think not exactly, Mr. President.

President Davis. Won't you correct me, then?

Mr. McInnes. I think we voted at our last meeting that the questionnaire be sent out, did we not? This is simply a discussion, to help the thing along, to get the members present from both sides to express their views.

President Davis. Then did the meeting last time vote on the wording of the questionnaire, — the three questions that are given here?

Mr. McInnes. They might be changed.

President Davis. That is not mandatory? That is still optional with the committee?

Mr. McInnes. Yes, sir. If Mr. Wood could suggest a little more definitely to whom we should apply, so that we could know whom to deal with, I should personally be very glad to do it that way. But I think there are a lot of gentlemen here who should tell us what they think about it.

President Davis. I do not want to suggest closing the discussion prematurely, but I think there are others here who would like to talk on it. Apparently Mr. McInnes is very anxious to have them heard.

Mr. Charles W. Sherman. Mr. President, I do not know as I have very much to say on the matter, and I certainly do not think we want to instruct the committee which has been working on this matter so long, and has it so well in hand. But I think the committee as a whole will agree with Mr. McInnes's sentiment, — that they will welcome any suggestions from the manufacturers. Nevertheless, I think it ought to be left entirely in the discretion of the committee whether they will accept the suggestions or merely consider them. I think the committee should make up such a questionnaire as they think ought to go out. But I do think it would be a great help to the committee, as Mr. Wood suggested, if the manufacturers would frame such questions as they think ought to go out, and discuss those questions with the committee. I, for one, would be glad to see the questionnaire expanded to cover anything which would help in reaching a final decision on this matter.

Mr. J. M. Diven. I should like to take exception to one remark that was made. That is, if the amswers are negative, the work of the committee will end. It seems to me that the work should continue whether the change is made or not. I think that the specifications of the two associations should be reconciled so that there will be only one set — a real standard.

Then, for the benefit of the committee, I would say that personally I object to the use of the word " fittings." It is going to be confusing to the minds of the water-works people. We have always understood the word " fitting " to mean steam fitting, and so forth. Special castings is not the right term. Some word better than " special casting " or " fitting " should be devised. I think the committee should consider that.

PRESIDENT DAVIS. What would you suggest?

MR. DIVEN. I haven't anything to suggest. But I do not like either word. I should prefer the old word to the new, because the new word is confusing. It will give a new use to a word that we have used all our lives for something else.

MR. A. B. COULTERS. Mr. President, I should like to ask what word has been used by the American Association to cover that article.

MR. WOOD. " Special castings," they call it.

MR. SHERMAN. It seems to me on that same point that the term " special castings " is worse than the word " fittings." I think Mr. Diven's comment has some force, but when it comes to regular specials, and special specials, that is worse than using the word " fittings," even though it also is used for steel and wrought-iron pipe.

I think the other point probably is well taken. The committee ought not to cease its labors, no matter what the answers are, until we get new specifications. There are inconsistencies in both sets of specifications as they now are. They are along different lines, quite materially different, and it ought to be possible to bring them together without any material change of the bases on which they are at present made up if the changes suggested by the committee are not adopted. Their inconsistencies at least ought to be eliminated from both sets of specifications.

MR. MCINNES. I do want to say that some of the committee are getting old, and can't live much longer.

PRESIDENT DAVIS. I take it the committee is continued until it makes its final report and is discharged. So that I assume the committee will continue anyway. Mr. Conard, you are a member of this committee.

MR. W. R. CONARD. Well, Mr. President, I was rather in hopes that we should hear from some of the other members of the Association before any of the other members of the committee had anything to say. I do not know that there is anything that I as a member of the committee could add particularly to what Mr. McInnes has already said about the feelings of the committee, in that we should like very much to know whether the New England Water Works Association as an association desires the committee to actually revise and get out an entirely new set of specifications, or whether they want us to proceed and reconcile the present specifications, or endeavor to reconcile the present specifications with those of the American Water Works Association. Unless entirely new specifications are to be gotten out, some such reconciliation should be made, most assuredly. As some — at least the older members of the Association — may recall, the present specifications of the New England Water Works Association have been in operation for quite a number of years. They were admittedly not perfect when they were produced. And it was thought at the time that, as time elapsed, as the state of the art, both from the manufacturing standpoint and from an engineering standpoint, might indicate that there were changes and revisions desired, it might be well to make changes. And it has been a matter now of over five years — practically six years — since the committee was appointed the last time, and evidently the thought at the time the committee was appointed was that the time had arrived when there should be some revision. But the committee have been working along, and matters have reached the point where the general membership have indicated to the committee broadly what their desires are, and the question has arisen in the minds of the committee whether they want a complete revision or a reconciliation with the American Water Works specifications.

As to the questions or discussion which have arisen at the joint committee meetings between the committees of the American Water Works Association and the New England Water Works Association, the last joint meeting that was held, as you know by the printed letter that was sent out, after discussing the various phases and provisions of the tentative specifications, there was a motion adopted and agreed to by the representatives of the manufacturers that were present at that time, that after a lapse of time another joint meeting would be held at which the manufacturers would be permitted to present to the joint committee their favorable or unfavorable comment, and if unfavorable their objections to the various provisions of the specifications. One, the probable cost of making the changes necessary to make pipe for the various nominal diameters and uniform outside diameter; another, the provisions for obtaining something in the way of uniform metal, either by means of chemical specifications or physical qualities, or both; others of lesser importance, yet of sufficient importance, for the committee to have information on, — that of the provisions for the hydrostatic test and the provisions for coating.

On the matter of uniform outside diameters, and obtaining variations in classes by means of varying the core diameters, there have been in the last few years adopted by some of the manufacturers of this country cores for small pipe similar to those in force in some of the European countries, — England, and also on the Continent, — known as "Skilley" cores, made from horse droppings. Others of the manufacturers have adopted what is known as the "Fletcher core." This is a paper preparation that they use in place of the hay rope.

Those two methods of making cores will militate somewhat against varying the core diameters. They have been adopted by the manufacturers with a view to producing a better pipe, and the manufacturers are to be commended for their endeavors to produce better pipe, and therefore are entitled to consideration in some of their contentions.

Mr. McInnes spoke also of the question as to whether the users in general wish a uniform outside diameter, or whether they are satisfied with the present variations as provided in the present specifications. That is a matter that the questionnaire should answer.

The matter of chemical requirement: If the manufacturers will show to the committee that that is absolutely impracticable, it would seem as though the physical requirements should be modified to the extent that would obtain more nearly uniform pipe among the various manufacturers. The pipe coming from one plant should be as nearly the same as is possible to that coming from another plant. That made in the eastern section of the country should be as nearly uniform in physical qualities to that made in the southern.

The matter of hydrostatic test: If the hydrostatic test is to perform its proper functions and to be a hydrostatic test, if with the present equipment that the foundries have they can't give a sufficient length of time to get the static test, they should provide themselves with sufficient additional equipment to do it and make the necessary, if necessary, rearrangements in their plants to do so. And if it is necessary in the matter of production cost to increase the cost of the pipe to the purchaser, the purchaser should be willing on his part, if he considers the hydrostatic test of value, to pay the amount necessary, or the increased cost.

In the matter of coating, that is such a broad question, and one that presents so many, many phases, that I hardly feel prepared to discuss it at this time.

MR. WILLIAM F. WOODBURN. The thought comes to me right now that there may be a good many of the superintendents present who may not be familiar with all of the ideas as suggested by the committee. For instance, the uniform outside diameter. Would it not be well to have the chairman of the committee explain to the superintendents present their idea of suggesting this uniform outside diameter; and then let us hear from some of the superintendents as to whether they feel that it is necessary to call for a uniform outside diameter.

PRESIDENT DAVIS. I think Mr. Woodburn's suggestion is a good one. He suggests that the chairman of the committee explain the reason why the uniform outside diameter has been made, and then ask the superintendents here who have had practical difficulties to give offhand their experiences along those lines, or their thoughts about it.

MR. MCINNES. The general idea of the outside diameter is very simple. It is that every pipe and fitting of one nominal diameter will fit in every other one, that we shall not have the trouble we have had in the past of finding a B pipe which it is impossible to connect with a D pipe or an E pipe; but every spigot will enter every bell of the same nominal size. In other words. every 24-in. pipe of every weight shall enter every other 24-in. pipe. That is all there is to the uniform diameter. It sounds very simple and easy, but from a foundryman's point of view it is difficult, without any doubt.

PRESIDENT DAVIS. Mr. Woodburn's further suggestion was that if there are any superintendents here who have had experience or have ideas along that particular line, they shall give them to us.

MR. WOODBURN. What I wanted to bring out was, if there are any superintendents here who feel that they would like to couple pipe designed for 173-lb. pressure on to Class A pipe, designed for 43-lb. pressure. In other words, aren't they taking a chance that they are unable to take at the present time in putting light pipe in the line where heavy pipe should go? If they are to be able to couple two pipes together, whether they would not do it. Whether it is worth the additional expense as suggested by the committee.

PRESIDENT DAVIS. Mr. Gear, we haven't heard from you.

MR. PATRICK GEAR. Mr. President, my dear friend, Mr. Diven, said that we should change the word "special casting." I agree with him. Call it some other name, because if we find a special casting that does not fit and we call their attention to it, they will say that it is a special casting. Now, it is kind of provoking when a fellow is out a couple of miles from his shop, and he gets out there on a tee that is broken, where he has a line shut off, and he has a tee and a sleeve, and a piece of pipe, and he gets the pipe out and it is supposed to fit, and then he finds that it won't go. Now, if there is any way that the manufacturers could make the outside diameters all the same size, — whether A, B, C, D, E, or F, — they will confer a great blessing upon us and we will take our hats off to them every time we meet them. They can do that without any great expense to themselves. And if every man who makes a special casting, whether a tee, gate or sleeve, will make them all so that they will fit a B pipe or an E pipe, then a lot of our troubles will be taken care of.

Some years ago we would get a carload of pipe from the foundry. It would be a Class E pipe and be all right and fit. It would be good material and you could cut it and it would break where you intended to cut it. About three years ago I wanted some pipe in a hurry, and I sent for a carload, and it came. I don't know how it happened that it was not all broken up when it got there. The order was cancelled on all that pipe, and we had to send our order down to Mr. Conard to inspect it. A few years ago we got good pipe without inspection; now we can't. I don't know why.

Whether the manufacturers want Mr. Conard down there to inspect all their pipe or not I do not know, but he has got to be there if we want good pipe. He sends me a list of all the pipe that he throws out, and the different troubles that were in the pipe, and the rejections that we have had — selecting your army is nothing compared to our rejections.

If the manufacturers can make a good pipe, that won't break when you cut it, and the hammer won't go through it — by the way, this order I spoke about, I wrote to the concern that made the pipe and they couldn't understand it. So I got a lot of it in lengths about a couple of feet long and shipped it down to them, and they thought it was stove pipe. I did myself. The manufacturers can make a better pipe, and if this committee can get a pipe which will be uniform on the outside, and all classes of pipe will fit all classes of fittings, and if the men who make the fittings and who make the gates will make the gates so that they will fit all other pipe, a great deal of our trouble will cease.

We want a uniform outside diameter for all pipe, no matter what the class is, and a uniform inside diameter for all fittings, — we want the same size to fit any kind of a pipe.

Mr. James W. Dillon. I do not suppose there is a waterworks superintendent present, or anywhere in the world, who has not had his troubles with misfit pipe. But I am thinking that if the outside diameter is to be the diameter of the heaviest pipe, what kind of a time we would have in connecting one of these new pipes with the old Class A pipe.

Mr. Frank L. Fuller. I have had very little trouble in the experience I have had with pipes going together. The greatest trouble that I can remember is in connecting some of the Builders Iron Foundry's quarter bends on to the pipe that was provided for that purpose, especially on entering a reservoir. Several times there we have been obliged to cut off the bead and perhaps have the pipe turned down. But the ordinary straight pipe, and the ordinary specials that have been furnished, largely by the Builders Iron Foundry, to connect with this straight pipe, I have had very little trouble with. Oftentimes I have thought the bells on the gates were rather large, and required pretty large joints, but had no serious trouble after the joints were made. So that while this uniform pipe diameter probably would be a good thing, I have had very little trouble myself with the old style of things. The ordinary joint that I have used has been $\frac{3}{8}$ of an inch, I think, and that is sufficient to allow for all necessary variations in the size of the pipe, in the bead at the spigot end of the pipe.

MR. COULTERS. Everybody knows that before the adoption of the standard pipe specifications by both the American and New England Associations, the pipe specifications were in a chaotic condition. Every manufacturer had specifications of his own, and he hated like fury to deviate from them in the slightest way.

We were in the same predicament. Two manufacturers would rarely adopt the same specification, and the result was that there was trouble. Nobody denied it. There was difficulty in making fittings go together. But after the adoption of the specifications, the Builders Iron Foundry knew what was to be, — at least we knew what the specifications were. We followed that out, and the result has been that where we used to have fifteen or twenty complaints in the run of a month, and probably somewhere in the neighborhood of seventy-five or one hundred during a season, regarding the failure of our fittings to go together with pipe of other makes, we have not in the last four or five years had a single one which upon investigation proved that our fittings were to blame.

Previous to the adoption of the specifications, we were to blame for at least a part of the trouble that always prevailed. Since the specifications have been in use we have had some complaints. One or two that I have investigated have been where our bells were not large enough to accommodate the spigots on the pipe with which they were to be used. On investigation it was found that the spigot bead on the pipe was large, and that while the form laid down in the specifications had apparently been adopted it had not been carried out. The result was that instead of a spigot bead having at its extreme end a corner having a radius of $\frac{1}{8}$ in. or $\frac{1}{4}$ in. it had been carried out to a misshapen point which increased the diameter of the spigot sufficiently to prevent it being entered into the bell of any fitting; our make or any other. The bell was all right in this case, the spigot was to blame.

But to consider this thing from the manufacturers' standpoint. We are all interested in the welfare of the good old U. S. A. We understand that after this war is over we shall be called upon to furnish a good deal of material now furnished by others.

Now, if we are to do that it seems to me that we should do something looking toward the standardization of the pipe specifications of this country. This talk of changes does not perhaps affect the Builders Iron Foundry so much as it does manufacturers of straight pipe. There are some men who have been trying to make us believe that the change to a standard outside diameter is a very serious matter. It is apparent to me that the committee has been trying to find out what the objection is on the part of the manufacturers to making changes. That is, what the expense is likely to be and whether or not, in the light of that expense, a change is warranted. For my part it seems to me that it is a matter of having either several sets of patterns for different classes of pipe, or else having several sets of arbors to make cores on. In the first case, it would mean that the number of patterns for each nominal diameter of pipe would be limited to one where as now there are from two to four depending upon the completeness of the equipment possessed by any manufacturer. If we were to make the outside diameters for all classes of pipe of the same nominal diameter equal, the difference in the weight of pipe would be taken care of by the diameter of the core placed in the mould. In the case of a Class A pipe, the core would be larger in diameter than would be the case where a Class B pipe was to be made. The differences involved, however, are not great enough to call for anything more than a little extra care and a slightly increased amount of material in making cores on the same arbor for any one of several classes of pipe.

I cannot understand from anything that has been said what the objection is to making changes if they are really needed. If there are those among us who possess information along this line, now is the time to give us the benefit of it. But let us settle this matter. I believe that the adoption of a standard outside diameter and a standard size of bell would be a very good thing for us, provided it is deemed necessary to depart from the present specifications. But whatever we do let us settle the matter so that it will stay settled. Let us settle it so that the thing will be of some benefit not only to the New England Water Works Association but to the American Water Works Association and to the country in general. Something that will conform at least in essential details with another specification which has already been put into effect by the British Association. I do not know what their specifications are and am not advocating the adoption of them, but the action of British Association specifically shows that after due deliberation they have arrived at a definite conclusion, and it seems to me that we should do the same.

MR. GEAR. Speaking of special castings, I didn't know but Mr. Coulters might take offense. But the trouble with special castings that I have run up against has not been with those of the Builders Iron Foundry. I never have had any trouble with his special castings. The trouble I had was when the special castings were bought from the foundry which furnished the pipe; and we probably did not use them all in that line, we may have had a few left, and when we came to use them on some other line we got into trouble. We have had no trouble with the castings of the Builders Iron Foundry. When I mentioned special castings, I did not have reference to the Builders Iron Foundry, because I never had any trouble with theirs.

PRESIDENT DAVIS. Are there any other comments or remarks?

MR. H. V. MACKSEY. I quite agree with the line of argument given us by the Builders Iron Foundry Company. It seems to me unreasonable on the part of the manufacturers to simply say, " We won't, and we would like to know why you want us to; or we can't and we won't tell you the reason why." If their attitude is that " we are only going to make pipe thus-and-so, and we have let you go as far as we ever intend to in dictating to us what you shall use and what you shall purchase," why, let them have the courage to say so. If that is their way of looking at it, we should be glad to know it. And if we can't budge them we will take our medicine. But it seems to me that at the present time they are showing either a lack of courage or a lack of knowledge of their own business. They surely can't believe that the water-works superintendents, members of this Association, intend to insist upon anything that is unreasonable, however great an accommodation it would be to us to have it. But if we are asking for something unreasonable, tell us why. They do not care about the additional cost, because for every dollar they put into the pipe they put on the usual trade profit, and the more money they get into the pipe the greater their profit. They can't expect us to believe that, you know. The situation is this: That for some reason or other they are either too obstinate or too ignorant to do what we want or explain why they cannot do so.

Mr. Wood. When there is any strong outburst from the superintendents of water works asking for new specifications they will get them, and not until then. I have not heard more than about five men say that they wanted new specifications in these last six or seven New England meetings that I have attended. And I think when you get these questionnaires out you will be surprised to see how many come back saying the present ones are good enough.

As to whether you would rather have one outside pattern than a thousand for cores it is very easy to understand. I don't think it is necessary to go into details on that.

Mr. Macksey. I agree with what the gentleman has just said, — that when we really want it, we will get it, — and that they are going to lay back and make us show that we have got to have it. Why can't they do this in a polite way without waiting for us to fight and demand, or have a general uprising or Bolsheviki riot? Why not do things in the more businesslike manner?

President Davis. We have heard a good deal about the history attending the conferences between the manufacturers and the committee in the past. I do not suppose any of us here have any first-hand information, but I assume that, in so far as this meeting is concerned, the manufacturers and the superintendents through their committees are going to get together. And I heard no objection to Mr. Wood's suggestion that this questionnaire go out after there has been a conference between the committee and the manufacturers as to the nature and kind of the questions. So that I assume that this meeting now is in the way of finding out whether there is or is not a demand for a change, and if there is a demand for a change whether it will be along the three-point line suggested by the questionnaire, or by such other questions as the manufacturers may suggest and the committee may adopt. Is there any further discussion? Am I right, Mr. McInnes, in assuming that no action is necessary —

Mr. McInnes. I am sure the committee will welcome any suggestions from the manufacturers, to be incorporated, if the committee thinks helpful, in our questionnaire.

President Davis. I understand that at the last meeting the idea was adopted of sending out the questionnaire, and the committee is going to do that after conference. Are there any further remarks on this matter of uniform pipe specifications? [*No response.*]

PROCEEDINGS.

ANNUAL MEETING.

HOTEL BRUNSWICK,
BOSTON, MASS., January 9, 1918.

The President, Mr. Caleb M. Saville, in the chair.

The following members and guests were present:

HONORARY MEMBERS.

E. C. Brooks.
R. C. P. Coggeshall.
Desmond FitzGerald.
F. E. Hall.
G. A. Stacy.
F. P. Stearns. — 6.

MEMBERS.

F. A. Barbour.
J. F. Barrett.
A. E. Blackmer.
Bertram Brewer.
J. C. Chase.
F. L. Cole.
J. E. Conley.
C. E. Davis.
A. O. Doane.
E. D. Eldredge.
Frank Emerson.
S. F. Ferguson.
F. L. Fuller.
G. Ferullo.
Patrick Gear.
H. T. Gidley.
H. A. Hanscom.
A. C. Howes.
W. F. Howland.
E. W. Kent.
Willard Kent.
S. E. Killam.
G. A. King.
John Knickerbacker.
P. J. Lucey.
F. A. McInnes.
F. E. Merrill.
Leonard Metcalf.
A. E. Pickup.
C. R. Preston.
Ransom Rowe.
G. A. Sampson.
C. M. Saville.
C. W. Sherman.
J. Waldo Smith.
W. F. Sullivan.
H. A. Symonds.
L. D. Thorpe.
D. N. Tower.
W. H. Vaughn.
R. S. Weston.
F. B. Wilkins.
F. I. Winslow. — 43.

ASSOCIATES.

Bond, H. L. Co., by F. M. Bates and F. W. Mattheis.
Builders Iron Foundry, by G. H. Lewis.
Byers, A. M., Co., by H. F. Fiske.
Central Foundry Co., by W. H. Feltt.
Chapman Valve Mfg. Co., by J. J. Hartigan and C. E. Pratt.
Dixon Crucible Co., by H. A. Nealley.
Eddy Valve Company, by H. R. Prescott.
Edison Mfg. Co., by H. L. B. Watson.
Hersey Mfg. Co., by W. A. Hersey and J. H. Smith.
Hammond Process Co., by J. L. Flynn.
Lead Lined Iron Pipe Co., by T. E. Dwyer.
Ludlow Valve Mfg. Co., by A. R. Taylor.

National Meter Co., by J. G. Lufkin and H. L. Weston.
Neptune Meter Co., by H. H. Kinsey.
Pittsburgh Meter Co., by J. W. Turner.
Thomson Meter Co., by S. D. Higley and E. M. Shedd.
Union Water Meter Co., by H. W. Jacobs and E. D. Otis.
Water Works Equipment Co., by W. H. Van Winkle.
Wood & Co., R. D., by C. R. Wood.
Schramm & Son, Chris D., by J. W. Gleeson. — 26.

Guests.

Massachusetts. *Charlestown.* Mr. Teague.
Boston. H. P. J. Earnshaw and Samuel Prescott. — 3.

The Secretary, Mr. Willard Kent, presented his annual report as follows:

Report of the Secretary.

January 1, 1918.

Mr. President and Gentlemen of the New England Water Works Association, — The Secretary submits herewith the following report of the changes in membership during the past year, and the general condition of the Association.

The present membership is 1 002, constituted as follows: 14 Honorary, 901 Members, and 87 Associates, there being a net loss for the year of 41. The detailed changes are as follows:

MEMBERSHIP.

January 1, 1917.	Honorary Members	17			
	Died	3			
		—			14
January 1, 1917.	Total Members		942		
	Resigned	47			
	Dropped	27			
	Died	15			
		—	89		
			—	853	
	Initiations:				
	January	4			
	February	6			
	March	3			
	June	3			
	September	11			
	November	4			
	December	2			
		—		33	

	Reinstated:				
	Member resigned in 1911	1			
	Members dropped in 1916	5			
		—	6		
	Elected 1916, qualified 1917.		9		
			—	15	
				—	901
January 1, 1917.	Total Associates		84		
	Resigned	3			
	Dropped	1			
		—	4		
			—	80	
	Initiations:				
	March	1			
	September	2			
	December	2			
		—	5		
	Reinstated:				
	Associates dropped in 1916		2		
			—	7	
				—	87
January 1, 1918.	Total membership				1 002
January 1, 1917.	Total membership				1 043
Net loss					41

The Secretary has received and paid to the Treasurer,		$7 610.70	
Of this amount, the			
Receipts from initiation fees were	$217.00		
From dues of members	2 716.00		
From dues of members, fractional	29.25		
From dues of members, past	15.00		
		$2 977.25	
From dues of Associates	$1 275.00		
From dues of Associates, fractional	26.25		
		1 301.25	
Total from dues			$4 278.50
From advertisements			1 702.50
From subscriptions			300.75
From JOURNALS			419.00
From sundries			909.95
Total as above			$7 610.70

There is due the Association at this date:

For advertisements	$85.00
For specifications	.60
For JOURNALS	2.50
For reprints	58.50
Total amount due	$146.60

Respectfully submitted,

WILLARD KENT, *Secretary.*

On motion of Mr. Frank L. Fuller, it was voted that the report of the Secretary be accepted and placed on file.

The Treasurer, Mr. Lewis M. Bancroft, submitted the following as his annual report:

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and interest		$231.15
Initiation fees	$217.00	
Dues	4 061.50	
Total received from members		4 278.50
JOURNAL:		
Advertisements	$1 702.50	
Subscriptions	300.75	
Sale of JOURNALS	419.00	
Sale of reprints	14.45	
Total received from JOURNAL		2 436.70
Miscellaneous Receipts:		
Sale of " Pipe Specifications "	$20.20	
Dinners	768.00	
Certificates of membership	34.50	
Buttons	6.75	
Index	1.00	
Meter rate sheets	9.25	
June excursion	24.80	
Portland Convention Committee	23.17	
Boston Society of Civil Engineers	100.00	
Manufacturers' Association	1 000.00	
Miscellaneous	4.65	
Total miscellaneous receipts		1 992.32
Total receipts		$8 938.67

LEWIS M. BANCROFT, *Treasurer*,

In account with the New England Water Works Association.

	RECEIPTS.	
1917.		
Jan. 1.	Balance on hand	$2 419.57
	Received of Willard Kent, Secretary	7 610.70
	Interest on bonds and deposits	225.80
	Manufacturers' Association	1 000.00
	Portland Convention Committee	2.17
	Boston Society of Civil Engineers	100.00
		$11 358.24

EXPENDITURES.		
Bills paid		$8 253.65
BALANCE ON HAND.		
People's Savings Bank	$2 000.00	
Mechanics Savings Bank	403.66	
First National Bank	648.70	
Liberty Trust	52.23	
		3 104.59
		$11 358.24

ASSETS AND LIABILITIES.

ASSETS.		
Cash balance in banks		$3 104.59
Bonds Nos. 2642 and 2644 Lake Shore & Mich. Southern R. R., due May 1, 1931. Book value, $1 815.00. Market value		1 695.00
Accounts receivable:		
JOURNALS	$2.50	
Advertisements	85.00	
Specifications	.60	
Reprints	58.50	
		146.60
		$4 946.19

LIABILITIES.	
Accounts payable:	
Samuel Usher	$865.20
Brunswick Hotel Co.	174.50
A. D. Handy	12.00
Boston Mailing Co.	1.00
Fleming-Hughes-Rogers Co.	12.75
Miss Joan M. Ham	104.05
Boston Society of Civil Engineers	137.50
John A. Lowell Bank Note Co.	2.40
Hobbs & Warren	6.73
D. Gillies' Sons	26.00
Surplus	3 604.06
	$4 946.19

READING, January 9, 1918.

LEWIS M. BANCROFT, *Treasurer.*

Expenditures.

Journal:			
Advertising agent's commission		$233.00	
Plates		58.21	
Printing		1 893.30	
Editor's salary		300.00	
Editor's expense		27.75	
Reporting		194.28	
Advance reports		27.50	
Reprints		140.00	
Envelopes and postage		82.48	
			$2 956.52
Office:			
Secretary's salary		$200.00	
Secretary's expense		40.33	
Assistant to Secretary, salary		756.60	
Assistant to Secretary, expense		229.08	
Rent		550.00	
Printing, stationery, and postage		334.91	
Membership lists		264.79	
			2 375.71
Meetings and Committees:			
Stereopticon		$20.00	
Dinners	$669.82		
Cigars	44.70		
Music	48.00		
		762.52	
Printing, stationery, and postage		136.41	
Reporting		49.60	
			$968.53
Treasurer's salary and bond			67.50
Certificates of membership			3.90
Flowers			31.70
Income tax			1.71
Brackett medal			6.00
Standard specifications			3.00
Furniture			486.91
September convention			772.93
Index			579.24
			$8 253.65

On motion of Mr. Desmond FitzGerald, it was voted that the report of the Treasurer be accepted and placed on file.

Mr. E. D. Eldredge, chairman, submitted the following report of the Auditing Committee:

REPORT OF AUDITING COMMITTEE.

BOSTON, MASS., January 8, 1918.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers.

Respectfully submitted,
E. D. ELDREDGE,
A. E. PICKUP,
BERTRAM BREWER,
Auditing Committee.

On motion of Mr. Desmond FitzGerald, it was voted that the report of the Auditing Committee be accepted and placed on file.

OTHER COMMITTEE REPORTS.

Mr. Frank A. McInnes for the Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings, submitted a report which is printed in full on page 70.

On motion of Mr. Charles W. Sherman, it was voted that the report of the Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings be accepted, its recommendations adopted, and the committee continued.

Mr. Sherman suggested that the printing proposed by the committee be done in the JOURNAL, so that it may be made a matter of permanent record, rather than in a separate pamphlet which may easily be lost or destroyed. The President said the suggestion seemed to the chairman a good one, and if no objection was made it would be adopted.

MR. FRANK A. BARBOUR. I think I am a member of the Committee on Leakage; indeed, I think I am the chairman of that committee, although I had really forgotten that there was such a committee until I was reminded of it a few minutes ago. Nothing has been done during the present year, and I somewhat question whether anything will be done until the war is over, certainly not so far as I am personally concerned. Some time ago I outlined a very considerable amount of work, and I endeavored to unload some of it on our honored President, and some of it on the incoming President, but I never quite got around to it. It may be that during the coming year I may find time, but if not, it will have to wait.

The President. The Chair would like to say that Mr. Barbour has done all the work of the committee that has been done, and a year ago — I think it was — he made a very able preliminary report, but since that time nothing has been done. Do you care to make any suggestion, Mr. Barbour, as to having the committee continued?

Mr. Barbour. I don't think it will do any harm to continue the committee.

Mr. Robert Spurr Weston. I am secretary of the committee of which Mr. Whipple is chairman, on Water Purification Plant Statistics. We would like to continue our work. We intended to have a report ready at this time, but, owing to the absence of Professor Whipple in Russia, and other matters connected with the war, the committee has been able to meet but once this year. We have a large mass of data which we would like to present at another time. When it can be presented is very uncertain, but we would like to be continued.

The President. If there is no objection that course will be taken.

Address by the Retiring President.

The President. The next thing upon the program is the annual address by the President. What I have to say, however, will be rather in the nature of an informal talk than an address. There are one or two things that have happened this year that it may, perhaps, be well to speak of. It is our custom not to mention the names of members of the Association in thanking them for any special service rendered, so I will dodge that rule by thanking the committee of the Manufacturers' Association collectively for the help and the interest shown by them at the annual convention. It also seems to me that the loyal and substantial support that was given by the associate members at the last meeting, in the matter of the increased dues, is a very strong indication of the virility of this Association, and that the fact that those members came forward as they did, with their help, is worthy of special mention.

There is also the matter of the necessity of attracting young men to our Association, in order to interest them in our work and keep our ranks full. We do not need to be told that time flies, and that the present members of the Association are rapidly growing older. As I look down across the tables here I see the same faces that I have seen for many years, and the younger men do not seem to be coming in as they should to take our places. So I would respectfully suggest to the incoming administration that, if possible, in some way particular inducement be made to the younger men to interest them in the Association.

There has been a slight decrease in the membership during the year, which, perhaps, was inevitable after the strenuous efforts which were made for a larger membership, and it is not at all disheartening or discouraging, I think. The annual convention was well attended, and the attendance was especially noticeable in this year when so many conventions were given up and so many of our members were kept away by Government business. The papers, some of them especially, were of marked excellence, and presented by men who have spent their lives in special work, and they form a great contribution to our files and records.

Another notable milestone was the first award of the Dexter Brackett memorial. That is bound, as years go by, to be striven for more and more by practical water-works men. Along that same line it seems to me a strong effort should be made to attract papers and discussions from such men on maintenance problems, as well as from specialists.

The reflection of the high cost of living, of course, is found in the necessity for increasing our dues, and that does not need to be commented upon. But the higher cost of materials, supplies, and labor must be met by increased care in laying out work, better organization and closer coöperation among water-works men, both those who consume supplies and those who sell supplies, the present crisis requiring on the one hand that only such work be done as is necessary. But, on the other hand, we should realize that no man can tell the future, and therefore it is good judgment, perhaps, not to postpone too much work. We must meet the matter in a broad way, and work that is necessary should go on; and it may be, perhaps, financially easier to do it now, even although it may cost more than formerly. Certainly matters of water purification, metering of supplies, laying out of systems, etc., are necessary for the public health and public welfare, and it seems to me that they should go forward.

This, gentlemen, is all I am going to say to you to-day. I thank you very much for the loyal support I have received on all sides, and particularly from the officers of the Association. My best wish to my successor is that he may receive, as I know he will, the continuation of this support. [*Applause.*]

The next business is the report of the tellers to canvass ballots, and I will call on Mr. Coggeshall.

Mr. R. C. P. Coggeshall submitted the report of the tellers.

REPORT OF TELLERS.

Whole number of ballots	272
Blank	6
President.	
CARLETON E. DAVIS	253
Vice-Presidents.	
SAMUEL E. KILLAM	256
HENRY V. MACKSEY	258
FRANK A. BARBOUR	261
PERCY R. SANDERS	259
THOMAS MCKENZIE	258
HENRY R. BUCK	259
Secretary.	
WILLARD KENT	260
Treasurer.	
LEWIS M. BANCROFT	262
Editor.	
HENRY A. SYMONDS	258
Advertising Agent.	
HENRY A. SYMONDS	258

Additional Members of Executive Committee.

Frank J. Gifford	259
A. R. Hathaway	259
H. T. Sparks	259

Finance Committee.

George A. Carpenter	258
Edwin L. Pride	260
Bertram Brewer	259

Respectfully submitted,
R. C. P. COGGESHALL,
GEORGE A. KING,
W. F. SULLIVAN,
Tellers.

The President. It gives me great pleasure to hand over the office of President to one of the ablest water-works executives and managers in the country. I think the New England Water Works Association has honored itself in electing as its President Mr. Carleton E. Davis. [*Loud applause, the members rising.*]

Address of the Newly Elected President.

President Davis. Gentlemen, I deeply appreciate the honor of being asked to serve as the President of this organization. I assume that the Association from time to time desires to go outside of the strictly geographical limits of New England in the selection of its officers, and thereby demonstrate the fact that it is a national organization. New England thought is reflected throughout the entire country, and perhaps the entire world. New England water-works practice is just as widely known, and its influence is just as widely felt, and this is due in a very large measure to this Association and its members.

The Association has had a most enviable record in times of peace in the past thirty-odd years. It is now confronted with the question of what it will do in time of war. That is a question we are all thinking about to-day, — not only what we shall do individually, or what our part in this great struggle will be, but what steps, if any, this Association ought to take in order to get into line.

It is absolutely true that "by their fruits ye shall know them." The question of preparedness is uppermost to-day. We know that the country, in a great many respects, is not prepared to take the part in the war that it should. But that is not the case in the matter of sanitary science, in the matter of camp sanitation, in the matter of water-works equipment and supplies, things which are just as essential as any other feature of the military preparedness of the country. And because the country is so well prepared and has gone forward rapidly along those lines, this Association can take a large measure of credit. The country has called many members of this Association to the training camps to help preserve the lives of millions of young men who are being trained to go abroad, and it has availed itself of the knowledge of biology, chemistry, and other water-works sciences which this Association has brought to the public notice and disseminated generally.

Now, with that record behind it, there is no question that this Association will take the right stand and do the right thing in the coming year, or the coming years, if the war should last. It is possible you may decide to go on practically as you have in the past. It may be possible to carry on these meetings as they have been carried on in the past. But those who know our history will know that, even if there is superficially the same routine of action, there is underneath a very strong — and possibly because of the fact it is not heralded abroad it will be all the stronger — desire on the part of every one of us to do our utmost in helping to win the war.

This Association is noted for its good-fellowship and the hearty coöperation of all its members. Probably none of us at any other time have stood so much in need of good-fellowship, of getting together and telling our difficulties and finding out the other man's experience, as we do at this particular time. We all have our every-day difficulties, and those difficulties have doubtless been enhanced and multiplied many fold because of the war-time conditions.

Water works, of course, are essential — perhaps more essential, in every-day life than any other line of work in the country; and if they are essential in times of peace they are even more essential in times of war. We know this to be the case even though the general public does not appreciate it, and at this time I feel that we ought to continue these meetings very much as we have continued them in the past, so that we can have the benefit of each other's help and suggestion. Of course that can only be decided from time to time and day to day as events develop, but I think we should at least start off with that view point. [*Applause.*]

Mr. Frank L. Fuller, civil engineer, Boston, Mass., occupied the remainder of the session by an interesting talk on "Porto Rico," illustrated by many stereopticon views.

Adjourned.

FEBRUARY MEETING.

HOTEL BRUNSWICK, BOSTON, MASS.,
February 13, 1918.

Mr. Carleton E. Davis, the President, presiding.

The following members and guests were present:

HONORARY MEMBERS.

E. C. Brooks.
R. C. P. Coggeshall.
Frank E. Hall.
George A. Stacy. —4.

MEMBERS.

L. M. Bancroft.
G. M. Batchelder.
A. E. Blackmer.
H. R. Buck.
G. A. Carpenter.
H. H. Chase.
F. L. Cole.
W. R. Conard.
F. A. Darling.
C. E. Davis.
J. M. Diven.
A. O. Doane.
E. D. Eldredge.
R. H. Ellis.
F. L. Fuller.
Patrick Gear.
H. J. Goodale.
H. A. Hanscom.
J. L. Howard.
J. A. Hoy.
Willard Kent.
S. E. Killam.
P. J. Lucey.
F. A. McInnes.
Hugh McLean.
H. V. Macksey.
J. H. Mendell.
T. A. Peirce.
H. G. Pillsbury.
C. R. Preston.
J. F. Ranger.
C. L. Rice.
J. H. Reynolds.
H. E. Salmonde.
G. A. Sampson.
P. R. Sanders.
H. W. Sanderson.
A. L. Sawyer.
J. E. Sheldon.
C. W. Sherman.
G. H. Snell.
H. A. Symonds.
E. J. Titcomb.
W. H. Vaughn.
R. S. Weston.
H. F. P. Wilkins. — 46.

Associates.

Bond, H. L., Co., by F. M. Bates.
Builders Iron Foundry, by A. B. Coulters.
Byers, A. M., Company, by H. F. Fiske.
Central Foundry Company, by R. W. Conrow.
Chapman Valve Mfg. Co., by J. T. Mulgrew and C. E. Pratt.
Edison Manufacturing Co., by H. L. B. Watson.
Goulds Mfg. Co., by Creed W. Fulton.
Hersey Mfg. Co., by J. H. Smith.
Lead Lined Iron Pipe Co., by T. E. Dwyer.
Mueller, H., Mfg. Co., by C. J. G. Haas.
National Meter Co., by J. G. Lufkin and H. L. Weston.
Neptune Meter Co., by H. H. Kinsey.
Rensselaer Valve Co., by C. L. Brown.
Ross Valve Mfg. Co., by William Ross.
Smith, A. P., Mfg. Co., by F. L. Northrop.
Thomson Meter Co., by E. M. Shedd.
Union Water Meter Co., by H. W. Jacobs and D. K. Otis.
Warren Foundry & Machine Co., by W. F. Woodburn.
Wood & Co., R. D., by Charles R. Wood.
Worthington Pump & Machinery Corp., by Samuel Harrison, W. F. Bird and E. P. Howard. — 25.

Guests.

Massachusetts.

Boston, George A. Caldwell, E. A. Barrier, G. E. Freethy.
Holyoke, James W. Dillon.
Westfield, W. H. Judkins. — 5.

Applications for membership were submitted by the Secretary, from James H. Dillon, Holyoke, Mass., engaged as water commissioner; F. S. Hastings, Verona, Pa., resident chemist and superintendent of filtration, Pennsylvania Water Company; Howard W. Green, Ancon, Canal Zone, sanitary engineer, Miraflores Water Purification Plant, Canal Zone; and Halbert P. Gillette, Chicago, Ill., editor *Engineering and Contracting.*

On motion of Mr. Frank L. Fuller, the Secretary was empowered to cast one ballot in favor of the applicants, and, he having done so, they were declared elected members of the Association.

The report of Committee on Revision of Standard Specifications for Cast-Iron Water Pipe and Special Castings, submitted at the January meeting, came up for discussion. Upon motion of Mr. Frank A. McInnes, it was voted to grant the privilege of the floor in the discussion of the report to manufacturers, makers, and others interested in producing pipe. The discussion was participated in by Mr. Charles R. Wood, of R. D. Wood & Co.; Mr. A. B. Coulters, of the Builders Iron Foundry; Mr. William F. Woodman, of the Warren Foundry and Machine Co.; Mr. Frank A. McInnes, Mr. Charles W. Sherman, Mr. J. M. Diven, Mr. W. R. Conard, Mr. Patrick Gear, Mr. Frank L. Fuller, and Mr. H. V. Macksey.

A letter from Mr. Trautwine was also submitted, suggesting certain changes in the proposed specifications.

Mr. Alfred O. Doane, division engineer, Metropolitan Water Works, Boston, Mass., read a paper on " Steam Pumping Engines." Mr. Frank L. Fuller, Mr. J. M. Diven, and Mr. F. H. Hayes, of the Hayes Pump Machinery Company, took part in the discussion.

Mr. Henry A. Symonds submitted the report of the Editor.

REPORT OF THE EDITOR.

FEBRUARY 13, 1918.

To the New England Water Works Association, — I present the following report for JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION for the year 1917.

The accompanying tabulated statements show, in detail, amount of material in the JOURNAL.

Size of Volume. — The volume is the largest yet published, containing 880 pages. The largest previous volume being number XXIV, of 1910, which contained 808 pages.

Reprints. — The usual fifty reprints of papers have been furnished to authors without charge and additional reprints when desired at the cost of the paper and press work.

Circulation. — The present circulation of the JOURNAL is.

Members, all grades	1 002
Subscribers	86
Exchange	24
Total	1 112

a decrease by 43 from the preceeding year.

JOURNALS have been sent to all advertisers.

Advertisements. — There has been an average of 29 pages of paid advertisements, with an income of $1 702.50, a slight increase over last year.

Pipe Specifications. — During the year the specifications for cast-iron pipe to the value of $20.20 have been sold. The net gain up to a year ago had been $296.45, so that the total net gain from this source to date is $316.65. These 169 copies of specifications on hand, or $16.90 worth if sold at retail.

The Association has a credit of $3.77 at the Boston Post-Office, being the balance of money deposited for payment of postage upon JOURNAL at pound rates.

The office of editor has been subject to many changes during the last year. Col. Richard K. Hale, after serving the Association as editor very ably since 1909, ending with the issue of the June, 1917, number, took his place with his regiment in the great war.

His successor, William S. Johnson gave the last months of his life to the service of his country. and the New England Water Works Association. After the death of Mr. Johnson, Charles Sherman, assisted by Samuel Killam, gave their time freely to the Association and completed the work on the September JOURNAL. The December number was gotten out by the writer, but was delayed, due to his having assumed the office at a late date and finding it necessary to take some time in acquainting himself with the work.

Respectfully submitted,

HENRY A. SYMONDS, *Editor.*

TABLE 1.

STATEMENT OF MATERIAL IN VOLUME XXXI, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1917.

Number.	Date.	Papers.	Proceedings.	Total Text.	Index.	Advertisements.	Cover and Contents.	Insert Plates.	Total.	Total Cuts.
1	March	123	38	161	..	32	4	4	201	9
2	June	149	10	159	..	32	4	8	203	15
3	September	190	32	222	..	31	4	1	258	5
4	December	130	43	173	10	31	4	0	218	0
	Total	592	123	715	10	126	16	13	880	29

NOTE. Owing to the changes in editorship referred to in this report, it has been found impracticable to complete tables No. 2 and 3 with accuracy. They are therefore omitted.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., January 9, 1918, at 11 o'clock A.M.

Present, President Caleb Mills Saville and members Carleton E. Davis, Samuel E. Killam, William F. Sullivan, Henry A. Symonds, Lewis M. Bancroft, George A. King, and Willard Kent.

On motion of Mr. George A. King, Prof. George C. Whipple, Arthur E. Blackmer, and Alfred D. Flinn were made a committee to recommend the award of the Dexter Brackett Memorial Medal for the year 1917.

Adjourned.

Attest,

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, February 13, 1918, at eleven o'clock A.M.

Present: President Carleton E. Davis and members Samuel E. Killam, Henry V. Macksey, Henry R. Buck, Lewis M. Bancroft, and Willard Kent.

A letter from Mr. George A. King, with reference to the compensation of the Advertising Agent, was presented, and, on motion of Mr. Killam, it was voted that the same be increased to twenty per cent. for the first year on new business secured.

The following applications for membership were received and unanimously recommended therefor:

For members: James H. Dillon, water commissioner, Holyoke, Mass.; Frank S. Hastings, resident chemist and superintendent filtration, Pennsylvania Water Co., Verona, Pa.; Howard W. Green, sanitary engineer, Miraflores Water Purification Plant, Ancon, C. Z., and Halbert P. Gillette, editor *Engineering and Contracting*, Chicago, Ill.

Voted, that the printing of the membership list be omitted for the current year.

Discussion was had on the subject of place for holding next annual convention, and the Secretary was instructed to write the members of the Executive Committee with reference thereto.

Adjourned.

Attest: WILLARD KENT, *Secretary*.

BOOK REVIEW.

BERTRAM BREWER

" METER RATES FOR WATER WORKS." By Allen Hazen.

Mr. Allen Hazen's latest book, " Meter Rates for Water Works," is fully up to the standard set by that author in previous publications. It is the " direct outgrowth of his service as chairman of the committee on meter rates of the New England Water Works Association."

Naturally, Mr. Hazen supports the findings of that committee in favor of a sliding scale with a three-rate charge, — domestic, intermediate, and manufacturing. Several chapters are devoted to illuminating analyses of the principles involved in the committee's form of rate, supplemented by practical examples.

At the same time the author acknowledged the difficulty in fixing uniform rates for a business where so many individual plants have grown up under their own peculiar conditions, and the consumers have become accustomed to and rather satisfied with rates which are not strictly equitable. Many specific rates are described and criticized constructively, in a laudable attempt to indicate practicable ways by which those in charge could make changes in line with more uniform and equitable methods.

Among other things discussed by Mr. Hazen are minimum rates, service charges, leaks which cannot be accounted for, and leakage in street mains.

There is nothing pedantic or drastic in his suggestions, yet one feels that the author speaks " as one having authority." It should be read by every water-works man. We also wish that every water taker under the metered system would read the chapter on " under registration of meters."

Owing to War Conditions the September Convention of the Association will not be held.

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OFFICERS

OF THE

New England Water Works Association.

1918.

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Edwin L. Pride, Public Accountant, Boston, Mass.
Bertram Brewer, Supt. of Sewers and Water Works, Waltham, Mass.

* * *

THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of about 1 000 men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are FOUR dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues TWENTY dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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New England Water Works Association.
ORGANIZED 1882.

Vol. XXXII. **June, 1918.** **No. 2.**

This Association, as a body, is not responsible for the statements or opinions of any of its members.

STEAM PUMPING ENGINES.

BY ALFRED O. DOANE.*

[*Read February 13, 1918.*]

Among the earliest practical applications of steam power was its use in lifting water. Thomas Savery, in 1698, patented in England, a steam pump which consisted of a receiver to which steam was admitted. The valve on the steam pipe was then closed and water was played on the outside of the receiver, condensing the steam and producing a vacuum. The water to be lifted was forced by atmospheric pressure through the suction pipe and check valve into the receiver. Steam was again turned on and the water forced into the discharge pipe through a check valve by the steam pressure. This was a very wasteful engine, and, as boilers at that time could not be made to stand more than 15-lb. pressure, it could only raise water to a limited height.

James Watt, who was the first to apply scientific principles to the design of steam engines, invented, in the latter part of the eighteenth century, several types of pumping engines, both single and double acting, condensing and non-condensing.

The Cornish condensing pumping engine, used for unwatering the mines of Cornwall, employed steam expansively and was quite an efficient machine.

In this country, Henry R. Worthington invented the well-known Worthington duplex direct-acting pump. The water end of this pump is almost ideal in handling the water, as it starts the column without shock, produces a uniform flow until the end of the stroke, and then gradually brings the water to rest. The steam end, however, is very uneconomical, as it is necessary to carry full steam pressure the entire length of the stroke in the high-pressure cylinders. By the use of compound and triple-expansion steam ends run condensing, considerable improvement in efficiency was obtained.

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* Div. Engineer Metropolitan Water Works.

The duty developed by the compound condensing engine of this type ranged from 50 to 60 million foot-pounds per 1 000 lb. of steam. Many attempts were made to obtain the economy of the crank and flywheel engine and still preserve the favorable hydraulic conditions of the water end.

The compensators or tail pinchers of the Worthington engine operated by storing up power during the first part of the stroke under full pressure, by means of compressing air in cylinders attached to an extension of the piston rod; after cut-off, the stored power was released, and assisted the expanding steam during the remainder of the stroke.

In the D'Auria pump, an oscillating column of water was employed as a substitute for a fly wheel.

For many years duplex double-acting pumps were almost universally employed wherever water was raised by steam power. All the leading pump manufacturers made pumps of this type. The Worthington, the Blake, Knowles and Deane were leaders in this field. These pumps were of comparatively simple design, and were easy to operate and maintain. They were strongly built and were very durable. Many are still in use after thirty or more years in service, and many more have been replaced by high-duty pumps long before they were worn out. They are still used as fire pumps in many mills, being admirably adapted for this service where economy of steam is not essential.

The late Dr. E. D. Leavitt was one of the pioneers in this country in the development of the modern high-duty pumping engine. He designed a crank and flywheel pumping engine for the city of Lynn, which had a capacity of 5 mil. gal. per day and made a great reputation for economy, showing a duty of about 104 mil. ft.-lb. per 100 lb. of coal. This engine is still in existence, but is not in regular service.

Other notable examples of Dr. Leavitt's work are the two engines of the Metropolitan Water Works, — one of 20 mil. gal. daily capacity triple expansion, at Chestnut Hill Pumping Station; the other which was originally erected at the Mystic Pumping Station of the city of Boston and moved to the Spot Pond Pumping Station when the Mystic Water Works were abandoned in 1898. This engine is of the vertical compound type, having a capacity of 10 mil. gal. per day.

There is also a 50 mil. gallon Leavitt sewage pumping engine in service at the Calf Pasture Station of the city of Boston.

George H. Corliss, the celebrated engine builder and inventor of the well-known Corliss valve gear, built a high-duty compound condensing engine of 3 mil. gal. capacity for the city of Pawtucket, R. I., which developed the remarkable duty of 133 522 060 ft.-lb. per 100 lb. of coal.

The rapid growth of urban communities, the introduction of modern plumbing, and better fire protection, made insistent demands for more water at higher pressure, while the gradually increasing cost of coal and labor operated against the low-duty pump. Some of the large manufacturing companies engaged in keen rivalry, which resulted in a rapid advance in the size and efficiency of pumping engines.

The Edward P. Allis Company, now the Allis-Chalmers Company, built a number of vertical triple-expansion crank and flywheel engines, designed by Edwin Reynolds. The Milwaukee engine, built by this company and installed in 1886, was the first triple-expansion engine for water-works service, and showed a duty on 80 lb. steam pressure of 120 000 000 ft.-lb. per 100 lb. of coal.

The Holly Manufacturing Company, Henry R. Worthington, R. D. Wood & Co., Bethlehem Steel Company, Wm. Tod Company, and others, have built successful engines of this type.

At the Chestnut Hill stations of the Metropolitan Water Works there are four vertical triple-expansion crank and flywheel Holly engines, one of 40 mil. gal. capacity and three of 35 mil. gal. capacity; also one 30 mil. gal. capacity Allis engine of the same type. This engine held for some time the world's record for economy, with a test record of 178 500 000 ft.-lb. per 1 000 lb. of dry steam, with a steam pressure of 185.5 lb. gage, and the head pumped against 140 ft.

The three low-service 35 mil. gal. capacity Holly engines tested together developed a duty of 157 349 000 mil. ft.-lb. per 1 000 lb. of dry steam, with a steam pressure of 150 lb. and a head pumped against of 45 ft.

The 40 mil. gal. Holly engine showed 175 066 000 ft.-lb. duty, with 152.1 lb. steam pressure and head of 132 ft.

With higher steam pressure and superheated steam, together with improvement in design, the duty of this type of engine steadily increased until in the case of the 20 mil. gal. Holly engine at the Bissells Point Pumping Station, St. Louis, a duty of over 202 000 000 ft.-lb. per 1 000 lb. of steam, with superheat of 100 degrees Fahr. and gage pressure of 160 lb., was reached.

Within the last three or four years the supremacy of the high-duty reciprocating pump has been challenged by the steam turbine driven centrifugal pumping unit. Great improvement in the design of both the centrifugal pump and the steam turbine and the development of an efficient and practical speed-reducing gear have made this result possible.

While the centrifugal pump has been used for many years, until recently its field has been limited to raising large quantities of water to moderate heights when economy of operation was not a controlling factor. The efficiency was low, averaging about 50 per cent., and most of the pumps were cheaply built for rough work. The modern centrifugal pumps show much higher efficiencies, ranging from 75 per cent. in medium sizes to well over 80 per cent. for the large pumps.

It is hardly probable that the mechanical efficiency of the water end of a centrifugal pumping unit can ever equal that of the best large reciprocating pumping engines, where the total friction loss as determined by the difference between the indicated and the water horse-power is sometimes not over five per cent.

While the high-grade steam turbine compares very favorably with the best reciprocating steam engines in economy, the lower efficiency of the water end is a handicap to the turbine driven centrifugal pumping unit.

The claim for consideration of this type of pumping engine does not rely entirely on its steam economy, but rather on the lower over-all cost of pumping due to its comparatively small first cost, light weight, little space occupied, and less cost for supplies and attendance; resulting in smaller capital and depreciation charges on buildings, foundations and engines, as well as reduced operating expenses. The centrifugal unit may also be built of much larger capacity than it is practical to construct the reciprocating engine.

When comparison is made with large high-duty triple-expansion pumping engines, the increased fuel expense, larger boiler plant and higher labor and maintenance expense made necessary by the lower duty of the centrifugal unit should be taken into consideration.

In the case of increasing the capacity of an existing pumping plant, the turbine driven centrifugal engine has considerable advantages, as it may be installed in a small space, — perhaps between two existing engines, or in a basement where it would be impossible to get a reciprocating engine of equal capacity, — thus possibly avoiding an expensive addition to the building.

If the new unit is to be used principally as a reserve to take care of peak loads and emergencies, the case is still more favorable to the centrifugal, as economy of operation is not of paramount importance, while the lower first cost, small space taken up, and the short time necessary to start up from a cold condition make it an attractive proposition.

An article by G. H. Gibson, in the *Engineering News* of September 3, 1914, gives an interesting comparison of a 30 mil. gal. capacity steam turbine driven centrifugal pump, built and installed by the DeLaval Steam Turbine Company in the Kirtland Pumping Station of the city of Cleveland, with the 20 mil. gal. Holly engine at the Bissells Point Station at St. Louis, each engine holding the record for economy in its class.

	Kirtland Centrifugal Pump.	Bissells Point Triple-Expansion Engine.
Capacity, gallons per day	30 000 000	20 000 000
Total head, feet	206	288.3
Steam pressure, pounds, gage	150	160
Superheat, degrees Fahrenheit	100	100
Duty guaranteed, foot-pounds per 1 000 lb. of steam	136 500 000	195 000 000
Weight, including bed plates, tons	57	875
Space occupied, feet	35 x 7 x 18	30.5 x 22 x 51
Price of unit, including condenser	$35 750	
Price plus bonus		$103 953
Date tested	Dec. 30, 1914	Apr. 23–24, 1914
Delivery, gallons per day	30 300 000	20 610 000
Head, feet	236.3	297.7
Suction lift, feet	21.7	——
Steam pressure gage	153.85	159.43
Superheat, degrees Fahrenheit	102.6	105.23
Vacuum, inches	28.25	28.00
Boiler horse-power required	545.7	350.1
Duty developed:		
Foot pounds per 1 000 lb. of steam	152 020 000	202 628 616
Foot pounds per 1 000 000 B.t.u.	128 400 000	166 719 796
Water horse-power developed	1 257.0	1 074.91

From the foregoing data it will be seen that the price of the centrifugal unit is a little more than one third, the weight about one fifteenth, and the cubic space occupied about one eighth of the corresponding figures for the triple-expansion engine.

The DeLaval Company has made a comparison of cost of pumping by these engines, based on a coal at a cost of $1.69 per ton, and, assuming that the plants were constructed in the same locality, and that the cost of buildings, foundations, and boiler plants would be $36 371 for the centrifugal and $90 503 for the triple-expansion engine. All fixed charges, including depreciation, repairs, and fuel expense, are included, but no attendance or supplies, and operation at full load twenty-four hours per day and three hundred and sixty-five days per year is assumed. The resulting annual cost per water horse-power year is $23.11 for the centrifugal, and $27.68 for the triple-expansion engine.

The price of coal used was the actual price in St. Louis at the time of the trial. It has a strange look to us in this locality and these troublous times, and it is hardly probable that such a low price will ever be seen again in any locality. With the normal coal prices which prevailed in Massachusetts before the war, the comparison would be in favor of the triple-expansion engine, under the conditions assumed.

Any comparison of costs based on prices which prevailed before the war is bound to be misleading, and the only way to get reliable information is to obtain actual estimates of cost from responsible manufacturers.

In comparing the relative advantages of the different types of pumps of the smaller sizes, say from 1.5 to 4 mil. gal. daily capacity, the centrifugal pumping unit comes into competition with the cross compound crank and flywheel reciprocating engine. The duties in this case are more nearly alike, while the advantages of weight and space occupied — particularly floor space — remain strongly in favor of the centrifugal.

The cross compound engine of this capacity will develop duties ranging from 115 to 135 mil. ft.-lb. per 1 000 lb. of dry and saturated steam, while the centrifugal unit may be expected to give from 85 to 95 mil. ft.-lb. on the same basis.

In comparison with the cross compound engine, the floor space occupied by the centrifugal is about one fourth, the weight about one sixth, and the cost in normal times, exclusive of foundations, about 60 per cent., for units of equal capacity.

It may be of interest to note some of the more important differences between these types of engine. The centrifugal pump operates by centrifugal force developed by whirling the water taken in at the inlet or eye by means of the rapidly rotating impeller, discharging it from the perimeter of the impeller at a velocity sufficient to overcome the head and other resistances pumped against. It follows that a given resistance requires a certain peripheral speed to overcome it. With constant speed if the head increases the flow diminishes, until the shut-off point is reached, when there is no delivery and the water is simply whirled around in the casing. If the head decreases, the delivery increases.

A gate may be shut on the discharge pipe while the pump is operating, without damage, if the water churning in the castings is not overheated by running too long in this condition. The pump should be provided with a foot valve or check valve; otherwise the water will run backward through the pump when the power is shut off, causing the impeller to rotate very rapidly and perhaps cause some damage.

It is common practice, where the lift is high enough to require two-stage operation, to use two single-stage pumps in series instead of having two impellers in the same casing. By this arrangement somewhat greater efficiency is realized. Sometimes the pumps are connected so that both pumps may deliver at their rated capacity against a head suitable for domestic service; or by connecting them in series they may be made to deliver one half the quantity against double the head, for fire service. In some installations a low-service and a high-service pump are mounted on a common shaft.

The steam turbine as a prime mover has been in general use but a comparatively short time. The early turbines were generally of the single-stage type, and, as the velocity of expanding steam is about 3 000 ft. per second to the atmosphere, or 4 000 ft. to a high vacuum, and, in order to obtain the best efficiency the buckets of a reaction turbine should move at the velocity of the steam, while those of the impulse type should move at one half this velocity, the result was bucket speeds of 1 500 ft. per second in commercial single-stage turbines.

If the periphery of the impeller of a centrifugal pump should move at this speed, a head of 35 000 ft. would be generated. By applying the steam several times to the same wheel, or employing a number of wheels arranged in stages, the velocity of the turbine may be greatly reduced, but is still too high for satisfactory results with any practicable diameter of pump impeller if turbine and pump are direct connected.

The problem has been solved by the development of a practical speed-reduction gear, which enables the turbine and pump to operate at the speed best suited to each, under the given conditions. These gears, which are generally of the double helical type, must be made and fitted with the utmost care and precision, using only the very best materials.

The speed-reduction gears are perhaps the most difficult part of the centrifugal pumping unit to construct and maintain, and it is very hard to construct them so that they will not make any objectionable noise, especially when the ratio of speed reduction is high. It is advisable to keep the turbine speed as low as practicable — not over 5 000 revolutions per minute for the small sizes and 3 600 for the larger ones. If all rotating parts are not in perfect running balance, or if the shafting is not in accurate alignment, serious vibrations may be caused.

The blades of the steam turbine sometimes give trouble by rapid corrosion, which generally reduces the efficiency. This is particularly apt to occur if there is excessive moisture in the steam, or with extremely high steam velocities. Trouble has also been experienced when using superheated steam, which sometimes causes the blades to crack and disintegrate.

The steam turbine is particularly fitted to utilize a high vacuum effectively, and for this reason should be provided with a high-grade air pump which should be of the independent steam-driven type, the exhaust from which may be profitably used to heat boiler feed water or may be put into an intermediate stage of the turbine and made to do useful work.

The high rotary speed of the shafting makes it very difficult to employ a mechanically connected air pump or feed pump.

In conclusion, it may be said that each type of pumping engine has its field of usefulness, and in selecting new pumping equipment the claims of each must be carefully considered from every angle, and the type selected which appears best suited to the conditions.

DISCUSSION.

PRESIDENT DAVIS. We have listened to a very interesting and instructive paper, which is now open for discussion. I presume likewise Mr. Doane will be willing to answer any questions.

MR. FRANK L. FULLER. I think that this paper has been very instructive to us, and it calls to my mind that there are a good many situations where a centrifugal pump can be installed so that it will be very much nearer the water surface than the reciprocating pump could be on account of the smallness of its size and the smallness of the boiler, you might say, or the space taken up by it.

And it seems to me it is going to come, although its efficiency may not be as great as a triplex pump or a reciprocating pump, or other form. Still, taking into account the small space required, the lightness of the pump and its cheapness of price, it seems to me it is going to fill a place where it will be very desirable to install these pumps.

Mr. J. M. Diven.* Do they offer any figures as to the comparative cost of operation?

Mr. Doane. I have not any figures of that kind, but perhaps our President could give us some.

President Davis. I can't give any figures from our experience, because the conditions are so varying. Sometimes the point where the turbine is put up, whether it is accessible or inaccessible — if it is inaccessible it may require the entire time of a man, whereas one man might operate two large pumps if close together. So many modifying factors come in that I do not believe, from my own experience at least, I could give any comparative figures of cost.

Mr. Doane spoke of the difficulty of maintaining gears. I have known of one or two cases where a very slight quantity of oil got into the water from the cooling box. And in those particular cases there were half a dozen nozzles spraying oil on to the gears, and the little drops of water which came in there through neglect — the men did not appreciate the situation — brought up a distinct line of heating in the gears directly under these nozzles. So that the elimination of little leaks is very important in connection with the gear question.

Mr. F. H. Hayes.† Out in the Pennsylvania region of the big steel mills where they began using 4-, 5-,6-, and 7-stage pumps for their boilers, you will find that they are going back to the first principles of the outside packed pumps with compound steam ends. Centrifugal pumps without a steam turbine have to be fitted to the conditions as much as we do if we go to a tailor's shop and have a coat fitted to us. If we grow big, the coat doesn't grow big; if we grow small, the coat doesn't fit us.

Now, the argument has been brought out here to-day that the centrifugal pump occupies a lesser space. If you can pump more water with a pound of coal with a triple-expansion pump. I would say you were warranted in using that agency for the best interests of the people who buy it,— not for the house that surrounds it.

---

* Superintendent Water Works, Troy, N. Y.

† Of the F. H. Hayes Machinery Company.

And I imagine that in less than five years, with all of the centrifugal pumps that are now in operation, we shall know more about them, for the reason that these things that we hear about them in regard to the duty being equal to the reciprocating pumps which should give just as good duty when two years old as when they were delivered. With the centrifugal pumps, if they have clear water, the life of the impeller is long; if they have dirty water, sometimes it goes to pieces very quickly. Any deterioration of impeller means loss of efficiency.

With a centrifugal pump there is no trouble in shutting up a valve in the discharge pipe.

But if a valve is shut up in the discharge pipe of a reciprocating pump, you will soon see what happens.

Let me recite a little condition which I know to be a fact, as I had to do with the putting in of a Duplex plunger pump. The water company had to furnish the locomotives of a railroad a great deal of water and the firemen are not careful in shutting the valves, with the result that, as they have so much water to handle, water-hammer develops in the pipes to a great extent; with the result that some one went to them and said they ought to use a centrifugal pump as it would stop the water-hammer. They did use a centrifugal pump and stopped the water-hammer, but it cost them fourteen dollars a day, to run it, more than the other pump did.

Mr. J. M. Diven. The old Worthington type of pump, giving 55 or 60 million pounds of duty, — a man would start his pump and fill up his oil cups and then perhaps go fishing after tending to his boilers. In fact, give the pump very little attention. You can't do that with the high-duty pump. This brings up the question whether there is not a point in small size where it does not pay to use a high-duty pump.

Mr. Doane. The firemen didn't have any vacation with those pumps you speak of. With the small pumps generally the engineer was the fireman, and I don't see where he had any time to go fishing.

Mr. Diven. Then you didn't have to have a fireman, the engineer could do both, which you couldn't in a five-million plant. Now, in that case you would have to charge up against the high-duty engine the salary of the fireman.

THAWING OUT FROZEN SERVICES.

BY D. A. HEFFERNAN.*

[*Read March 13, 1918.*]

Sunday morning, December 30, 1917, will not soon be forgotten by water-works men, as it inaugurated the most severe winter ever experienced by them. I have had twenty-eight years of service in the Milton Water Department and I never want to go through what I did during the prolonged cold spell, and I believe all superintendents feel as I do.

From December 30 to January 26, the Department worked hard and for ungodly hours, thawing out frozen services and removing burst meters, which we at first replaced with new meters until our auxiliary supply ran out and we began to see visions of having to purchase enough meters to reach a supply for three or four years ahead. From then on, we installed nipples in place of the meters. During this period, our thawing operations consisted of running a $\frac{3}{16}$-in. block-tin tubing through which boiling hot water was being pumped continuously into the service. This method proved entirely satisfactory during the first of the cold weather when services were freezing from the cellar wall out toward the street, but was not efficient when the frost had worked its way five or six feet into the ground, as it did in some places, and the services froze in the street.

The majority of the services laid to ordinary single houses fifteen or twenty years ago was $\frac{5}{8}$-in. lead, and it is impossible to push a block-tin tube, softened by hot water, to a great distance through small lead pipe laid without particular attention being paid to its straightness.

We have over 40 miles of services, and when you are told that they average 107 ft. in length, you may realize what a proposition we were up against when the services started to freeze in the street. They could not be reached with the thawing tube. In the majority of cases, fifty feet of tubing could be pushed into the service without even reaching the ice.

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* Superintendent Water Works, Milton, Mass.

When I found it impossible to cope with the situation with our own methods, I engaged an electric thawing apparatus. We began to use the machine on January 26, and from that day to the last day of February it was busy, under my personal supervision, which I knew was necessary from a financial viewpoint, as I had been through the mill in 1912.

For the benefit of those who have not seen this apparatus, I will give a brief description of how it works. It consists merely of a switchboard containing fuses, meter and switch, and a transformer and rheostat. It is necessary to take the current from the Edison primary wire carrying a voltage of 2 300. The current passes through the switchboard to the transformer, where its voltage is cut from 2 300 to 110, and from there to the rheostat which, in our case, consisted of a hogshead containing a solution of sodium chloride (common salt) and having a metal plate solid on the bottom and another plate which it is possible to raise or lower, as you desire less or greater amperage.

From the rheostat the current followed the secondary wire of 4–0 insulated cable which was clamped to the service pipe in the cellar of the house to be thawed, out through the service to the main, which it followed to the hydrant, to which the other secondary wire was connected; then back through this wire to the rheostat, transformer, switch, and finally to the primary again.

At first we went along swimmingly, cutting over secondary house circuits into primaries until the Edison Company woke up and forbade such operations. Thereafter, when primaries were not available, it was necessary to have a lineman make temporary installation of primaries, sometimes for a distance of eight hundred feet. The amperage used on different services varied considerably. Where long connections were needed, the greatest amperage we could get was sometimes only 150; at other times we used 500 amperes, while the ordinary amount averaged 350.

During thirty-one days, we thawed 140 services, of which 20 were private (being runs from a house to a stable, garage or greenhouse, and laid by the consumer) and for which we will make a charge, 4 hydrant branches, and a couple of short stretches of dead ends.

The average cost of thawing a service we found to be $12.46. Of course a short service cost considerably less, and the average was brought as high as it was because of the time consumed in the long jumps between jobs.

We were disappointed and discouraged several times when, a few days after thawing out a service, we received notice of its being frozen again. This we overcame by cutting a slot in the washer of one of the faucets, enabling a ¼-in. stream to flow continuously. Even at that, some consumers complained that what they considered undue noise got on the nerves of some delicately constituted member of the family, and to overcome it they put in a whole washer, with the result that they were again without water. We allowed these people to remain in that condition for a couple of weeks and we were not troubled again in that quarter.

After we had thawed a certain service out, we found the pressure to be considerably less than usual. A few days later a leak was discovered at the T. H. When this was dug up, we found a tail-piece melted. This was caused by the check nut having loosened somewhat, allowing an arc to make at that point and eating enough of the brass away to cause the leak.

We were unsuccessful at only one service. The current was brought from a distance of four hundred or five hundred feet. Neighbors were getting shocks from various sources. One man went to his cellar to shake the furnace and claimed he received a severe shock. Several others got it from faucets and telephones. There was a leakage somewhere in the ground, and the current did not reach the service to be thawed, but how it escaped, and where, we were unable to find out, even with the aid of a number of volunteer Sherlock Holmes amateurs.

However, on the whole, I found the electric thawing apparatus to be entirely satisfactory. It did its work quickly, cleanly, and cheaply.

Our average daily consumption jumped from 375 000 gal. to 500 000, during the period, as we had recommended every consumer to open one faucet enough to allow a ¼-in. stream to flow.

My estimate of the cost of the cold weather to the department follows:

Labor cost in excess of regular pay-roll	$847.29
Cost of electric thawing apparatus	1 472.23
Estimated cost of burst meters, 150 at $5	750.00
Excess of water consumed — 125 000 gal. daily for sixty-five days at $0.1336 per 1 000	1 085.50
Total	$4 155.02

From this must be deducted $545, to be charged against private work. It is not the intention of the department to charge the consumer for water used to prevent freezing, burst meters or thawing out, as they were not happenings caused by undue carelessness of the consumer. At the town meeting, an appropriation of $3 500 was granted to cover partially the expenses of the cold weather.

With 53 miles of mains, 40 miles of services, and 439 hydrants, I think you will all agree that Milton was very fortunate to get out of it as easily as it did.

DISCUSSION.

MR. PATRICK GEAR.* We had about 125 service pipes frozen in Holyoke. Ninety-two of these were thawed out with our own gasoline machine, by forcing hot water through block-tin pipe from the cellar to the main. Owing to conditions of some of the houses being built on terraces, others having elbows or offsets on the pipes, we were obliged to call upon the Gas and Electric Department to help us out with their electric appliance. The pipes that were thawed out by electricity were in different parts of the city, and in some instances it was necessary to run from 500 to 1 000 ft. of wire to get juice to thaw them out. Thirty-three services and four hydrants were thawed out by this process at a cost of $5.40 each,. and the services that were thawed out with our own gasoline thawing machine and hot water cost $3.60 each. We are very grateful to the Gas and Electric Department for the assistance they gave us, and furthermore the pipes that were thawed out by them we could not do unless we went to a much greater expense.

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* Superintendent Water Works, Holyoke, Mass.

The people in our city were very considerate, and not any of them complained. They simply said, " Come as soon as you can, and we will try and get along the best we know how." I never thought until this winter that the people had so much sympathy for water-works men.

Mr. Irving S. Wood.* Up to date we have had 4 950 cases of freezing. About 15 per cent. of our services froze up.

The President. How did you thaw them out?

Mr. Wood. Both by steam and electricity. We had five electric gangs and a half a dozen steam gangs. I couldn't say how many pipes have been thawed out, and I guess nobody knows.

Mr. Wright. Up in New Hampshire, where I live, we have had some pretty cold weather, but out of 1 300 services we have only had 7 frozen.

Mr. R. C. P. Coggeshall. How about the snow?

Mr. Wright. We had a tremendous amount of snow.

Mr. Coggeshall. How was it in Holyoke, Mr. Gear?

Mr. Gear. We had plenty of snow, and if it hadn't been for the street railway company taking the snow off the street we wouldn't have had any trouble with freezing at all. It was only where the street cars ran that we had any trouble.

Mr. Frank A. McInnes.† I agree with you, Mr. President, that there must be a lot of information obtainable on the subject of frozen pipes. If it were not for the great war which overshadows everything and makes us minimize our difficulties, the experiences of this past winter would have been considered in the light of a calamity, because of the serious trouble and damage to health and property due to frozen water pipes. We have been doing all sorts of things. We have been using alternating current through a transformer and rheostat, and direct current through a rheostat, and we have been making large use of storage batteries. We have gained a lot of experience, as everybody else must have done. Wouldn't it be wise to appoint a committee to get together the experiences of our members? We will probably not have another winter like this for a long time; there has been nothing like it since 1874–75 in Boston, with the same condition of early and continued cold without snow, and it is a glorious opportunity to find out what has been done. I should like to see a committee appointed for that purpose, provided I am not made one of the committee.

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* Civil Engineer, Providence, R. I.

† Boston Water Department.

A MEMBER. I should like to ask those who have been thawing with electricity if they have had any difficulty where leadite or hydrotite has been used as an insulator.

MR. HENRY A. SYMONDS.* I think that our experience this winter has shown that it is almost impossible to thaw out water pipe through a great number of leadite or hydrotite joints. We tried to use an electrical thawing apparatus on one system where all joints are of leadite, and had to abandon it after a short time, except for use in thawing from the service box to the house. Where there were more than three joints, we found it was difficult to thaw the pipe by electricity. In another plant where we had similar conditions, except that one half of the joints were lead, we had no trouble whatever in the lead section in thawing everything with the electrical device, but we abandoned its use as soon as we began on the leadite section. Composition joints are unfavorable for thawing frozen pipe with electricity, but prove excellent as a preventive of electrolysis.

MR. COGGESHALL. I will tell you one experience we had, in trying to thaw out a pipe on a large main. We couldn't get any current through it, and then our foreman happened to remember that an insulating joint had been placed there to guard against electrolysis. So he shifted the connection to avoid that, and then was able to thaw very quickly.

MR. FRANK L. FULLER.† We have about 1 700 services at Wellesley, and about 150 froze. The original pipe was covered about 4 ft. 9 in., and I presume additions that have been put in since have been about the same depth. I think the service pipes are down probably about 5 feet.

MR. GEORGE A. KING.‡ In two sections of our city, on two streets, eight or ten service pipes were frozen on one side of the street and none on the other.

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* Civil Engineer, Boston, Mass.

† Civil Engineer, Boston, Mass.

‡ Superintendent Water Works, Taunton, Mass.

Mr. Fuller. How about the sun?

Mr. King. One street ran northwest and southeast, I should say, and the other ran very nearly east and west.

Mr. A. R. Hathaway.* I had hoped that to-day I might get some information to carry back home with me, in regard to a question which Mr. Heffernan has touched upon in connection with this matter of frozen services, resulting from the abnormal frost conditions this winter. The information wanted is rather from the office point of view than from the superintendent's or the work side.

In Springfield we have had about eight or nine hundred services frozen in the street, besides about a thousand meters frozen, but practically no mains. With our limited means of thawing out the services, — which we attempted in the order in which they were reported, — many consumers were out of water, and while waiting their turn we tried to supply them to a limited extent by sending around water-carts of the street department. As fast as the pipes could be thawed out, the consumers were requested by the superintendent's men to let the water run to prevent a recurrence of the freezing in the street. Where meters were frozen they were taken out and stored in the shop, waiting future opportunity for repairing them. I should like information as to how others will treat the excess registration by meters left in, where such excess is caused by letting the water run by request of the superintendent's men. Six years ago we had a similar experience, but to a much smaller degree, and the water board at that time authorized the policy of making the ensuing bills for the normal amount which would have been naturally registered under ordinary conditions, and charging the excess consumption to a special expense account. I don't know how the matter will be treated this year, but the water board has directed that all bills be made for whatever registration is shown, where the meter is left in, and let the consumers present their requests for abatement, with their reasons therefor. These requests are to be held and accumulated until a special meeting is called for the purpose, when each request will be individually considered and a policy probably adopted.

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* Water Registrar, Springfield, Mass.

Besides the foregoing class of cases, we will have another class, where consumers have let the water run without such request or authority from the superintendent's division, fearing trouble in their service, and probably claiming that their action will have saved the water works from similar expense of thawing out in the street, or carting water to them.

A third class or group of consumers are already requesting consideration and remuneration of expense incurred by their employing plumbers to thaw them out in the street, stating that they could not wait for the city to do the work, and of course we have much sympathy for them.

These three different classes of claims are coming up for consideration in Springfield, and so I should like to obtain some expression of opinion from the members present, as to the probable policy others will adopt, or which may already have been adopted.

THE PRESIDENT. This is an interesting question, and opens up a wide subject for discussion.

MR. HATHAWAY. I have already sent out a questionnaire, or letter, to some seventeen different water works, stating the circumstances and asking for an expression of opinion and description of experience. I have had several interesting replies already, and any information and expression I might be able to obtain here will be of great help to our water board, and such interchange of opinion I am sure will be beneficial to all.

THE PRESIDENT. What has been the nature of the replies you have received?

MR. HATHAWAY. I have received three replies up to this time. I remember that in one of them the ground was taken that the consumers should bear their portion of the expense due to the abnormal conditions, in the same manner that the water works has to bear its proper proportion. In other words, neither the consumers nor the water works is to blame for such conditions, and therefore should share the burdens alike. Another reply stated that a policy would probably be adopted of allowing a fifty per cent. discount on the excess registration due to letting water run to prevent freezing. In Springfield we have always allowed no abatements on metered water bills, except in cases where excessive bills were caused by so-called blind leaks in underground or hidden piping, and in such cases the excess was divided with the consumer, where the trouble was found and promptly remedied.

Mr. A. E. Martin.* We have had in Springfield between one thousand and twelve hundred frozen meters, and something over eight hundred frozen services, and this in spite of the fact that for the last fifteen years at least we have been placing our service pipe 6 ft. in depth, and our mains are laid with 5½ ft. cover. We have had only one frozen main, and that didn't give us any trouble. We had three hydrants whose branches were cut off as clean as though they had been cut with a knife or a saw. Our theory about that was that it was due to the lifting of the hydrant by the frost. In one case we shall have some damages to pay on account of water getting into some of the cellars and into an electric light conduit, causing about six hundred dollars', worth of damage.

The services were thawed mostly by hot water with a block-tin pipe and force pump. Only about twenty-five per cent. of all we had frozen could be reached by the electric current which we got from the electric company, they furnishing our men with a transformer and we buying the wire and all the appurtenances. Where we could use the 2 300-volt current they charged us $1.50 for the electricity consumed, and 75 cents where we used the 110-volt house current. I can't tell you what the cost of thawing our services has been, because it hasn't been figured up as yet; but I wouldn't be at all surprised if the expense due to the calamity, if we may call it that, will total close to ten thousand dollars. The expense of repairing meters will be charged to the consumers for they were practically all in houses where they should have been taken care of. We made no charge for thawing the services, and, as Mr. Hathaway says, the question of charging for the water is for our board to decide.

Mr. McInnes. We have found the storage battery most satisfactory. It is flexible and does not depend on a wire in the street, but, of course it has its limitations, the same as any other method. And that is why I should like to have a committee appointed to collect all this information.

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* Superintendent Water Works, Springfield, Mass.

The President. You make that as a definite motion, I take it?

Mr. McInnes. Yes, I do.

The President. If the members are reluctant to discuss Mr. Hathaway's inquiry now, I suppose that the scope of the committee could be broad enough to take in a consideration of that question.

Mr. Hathaway. I thought, when Mr. McInnes was making his motion, that that would be a very proper thing to be included in the duties of the committee, and if we could have a report which would suggest a policy to be followed in the future I think it would be very useful.

Mr. McInnes. My primary object was to have the committee investigate and report so that our members next winter would know what is the most efficient and economical means of thawing pipes. I shouldn't like to get away from that, but I see no reason why the other could not be covered as well.

Mr. Hathaway. In talking with one of the members to-day, about this matter, he suggested that meters might have been all left in, where services were frozen and thawed in the street, and the tenants told to let water run; thus getting a registration of excess used for the purpose, which might properly be called an expense chargeable to the water works. But other consumers, who might not have had their services frozen, and had not been told to let the water run, might also have let the water run upon their own responsibility, and, as their meters would not be off for any purpose, the excess would be charged to them, although possibly the water works may thereby have been saved trouble and expense from their services not freezing. In these two cases, one consumer might have to pay for such excess and the other might not. If I were one of the latter class, I should object to paying for the excess. So I think the better way would have been to take off the meters where such trouble had occurred and leave them off until all danger had passed.

Mr. Heffernan. The frost in Milton is down five feet, and we have recommended that the consumers keep their water running to prevent the pipes from freezing, the department to make proper adjustment for all excess water above the normal consumption. In taking several readings of the temperature of the water supplying the extra high service in the Brush Hill section we found it extremely low, the average being 34 degrees. As my department has been very fortunate as far as breaks are concerned, and therefore having done no excavating, I made several inquiries relative to frost conditions nearby, and was informed that the frost was gradually working away from the pipes. If any member can give me any further information along this line I shall greatly appreciate it. As conditions seem to be now, it will probably be April 1 before we shall notify consumers to stop running the water.

THE PRESIDENT. I want to be sure that Mr. McInnes makes his motion and that it is properly seconded, so that a committee may be appointed, because I think that is very important.

MR. GEORGE F. MERRILL. I will second the motion.

MR. MCINNES. My motion was that a committee be appointed to report, not later than at the annual convention, in regard to the general subject of thawing frozen water pipes. That is the motion as I had it in mind originally, but I should be very glad to have any amendment made to it.

THE PRESIDENT. We will assume that the motion made is amended so that this committee can take up collateral subjects, such as Mr. Hathaway proposes.

[The motion is adopted.]

THE PRESIDENT. I don't think I can appoint the committee without further thought, for this is an important matter and we want to be sure that the gentlemen appointed on the committee will have time and disposition to work on it and be ready to report at the annual meeting. I will announce the committee later.

A MEMBER. Speaking about the temperature of water I will say that for about two weeks the temperature of the water in our mains was 32. It was really liquid ice; there was no difference between ice and the water, except in form. I should also like to express the opinion that part of our trouble this winter has been due to lack of rainfall during the fall months. Frost seems to penetrate dry ground deeper than it does wet ground. In wet ground there is the latent heat of the water which acts to retard the progress of the frost.

Mr. Frank E. Merrill.[*] Ihave understood that the water entering the mains from the Metropolitan reservoirs has been just above the freezing point. Perhaps Mr. Killam can tell us about that.

Mr. James W. Killam.[†] The water has been very cold. We have done the best we could, but the ice has been very thick in the reservoir, and the large quantity of water used made it necessary to take the water directly from the reservoir. The temperature has varied from about 34 up during the coldest spell.

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[*] Water Commissioner, Somerville, Mass.

[†] Superintendent Metropolitan Water Works.

THE BUILDING OF CAMP DEVENS.

[EDITOR. — We regret not being able to publish in this issue of the JOURNAL an article by Mr. Frank Barbour, embodying the substance of the very interesting address on the building of Camp Devens, given before the Association at the March meeting.

Unfortunately, shortly after reaching California, — whither he went with Mrs. Barbour, in search of much-needed rest, — Mr. Barbour came down with a severe attack of pneumonia, lay at death's door for some days, but is now happily on the road to recovery.

Mr. Barbour's address was followed by discussion by Mr. Leonard Metcalf and Mr. George W. Fuller, which are here given.]

MR. LEONARD METCALF. There are a few words I should like to say in simple recognition of the wonderful work done on this cantonment construction by its builders, as by other men on other cantonments.

When you stop to think that six months ago there was no organization to do this work, — because the Engineer Corps, to which it would have been entrusted, was so small that it could not do more than the work to be done in France, — and that in that period of time there has been built up in Washington an organization of about 350 men, and at the cantonment sites organizations involving about 200 000 men, which have built these camps at a cost of from eight to ten million dollars each, and that the whole work has been done at cost plus a profit of approximately one and a half to two per cent. to the contractors, I think you will say it is a record without parallel.

The form of contract provided for a sliding scale of profit — it was known as the " emergency contract " — the work to be done at cost plus profit, the scale of profit running from ten per cent. to seven per cent., depending on the magnitude of the work, and with the very important limitation of an up-set profit of $250 000 to the contractor. Out of that profit had to come the contractor's overhead, which I believe has been about $100 000. I know at one of the camps it was about $80 000; at another one of the camps, something over $100 000; and, I believe, on a third camp about that sum. Moreover, there had to come out of it the contractor's interest costs, which probably have amounted to from $25 000 to $40 000. So that out of the nominal profit from these 16 cantonments, which will involve a cost of $134 000 000, the nominal percentage profit of three per cent., corresponding to $250 000 at each camp — is cut to about two per cent. or somewhat less. And, mind you, these contracts were taken by the contractors with the understanding that the work involved would cost from three to perhaps four million dollars, while as a matter of fact they have done from eight to ten million dollars' worth of work without any increase in the estimated profits or the allowance to them. I think this is a most inspiring record.

Two or three references will give you an idea of the magnitude of the task before the Government. These 16 cantonments will involve a cost of about $134 000 000. They involve 26 500 buildings. They have involved the shipping, as shown by Washington records, — though there were many additional cars of which it did not have record, — of 77 000 carloads of materials — or 112 000 if you include also the National Guard camps, of which there were 16, which will involve an additional cost of about $36 000 000. The contracts, as Mr. Barbour stated, were let at varying dates from the middle of June to July 6, I think; and on September 5 or 6, after two months and a half at most of active construction, there could have been housed practically two thirds of the quota of men, or, in other words, about 450 000 men out of the 650 000 that the cantonments were to house; and they were substantially completed on December 5, or within six months' time.

With regard to the work at the various cantonments, it has been a work of good team play. The contract was of a form which made it possible to have good team play, prompt decisions on the ground; and when you get a combination such as we had at Ayer, — and I say "we" as representing the public, — with Captain Canfield — now Major Canfield — commanding quartermaster, Mr. Barbour in charge of the engineering work, and Fred T. Ley as contractor, you get a combination that can do almost anything, gentlemen. The record that they have made for themselves and for the Government is a wonderful record, deserving of the highest praise.

Now I come to the question of wastefulness. Various things have been said in the papers. For instance, when I was in Washington there were reports from some of the southern camps that lumber was costing sixty dollars which could be bought for twenty dollars odd, and that labor was being paid similarly high prices. Those reports were not true. Lumber was then being bought by the Government cheaper than it was being bought by private concerns or corporations, and certainly at prices which were absolutely fair to the Government, due to the work of the various committees of the Council for National Defense. For instance, in one case, which I chanced to have inquired into, the lumber was being bought for about $22 in the South, with from $4 to $5 railroad charges to be added, or at one half of the retail price referred to in the criticizing article.

This cantonment work was done by the building up of an organization to assist Brigadier-General Littell, — then Colonel Littell, — of the U. S. Quartermasters Corps, who was put in charge of the management of construction by authority of the Secretary of War, and he was given authority to report directly to the Secretary instead of having to report to the chief of his Department and he in turn to the Staff, which would have delayed the work very materially. Colonel Littell was assisted by two officers chosen by him, — Major Oury and Major Marshall, — Major Oury having charge of the enlargement of the existing works and assisting also in this new work, and Major Marshall being the more active of the two on the new construction. Major Oury has since been drawn into other work, and Colonel Marshall is now in command, Colonel Littell having been retired as a brigadier-general.

Under this military head an organization of civilians was drawn together, some of whom had had military experience. Major Gunby of this city, — one of Mr. Charles T. Main's partners, — was put in charge of design — a very happy choice, as it proved, because he is not only an exceedingly competent man but has a very happy faculty of getting along with men and getting work out of them. He has a very keen sense of humor and is an indefatigable worker. Major Hamilton, purchasing agent of the Stone & Webster organization, who gave up his work to take up this governmental position, was placed in charge of materials and transportation. The construction work was in charge of Major Whitson, one of the junior partners of Grant, Smith & Co., the contractors, of New York, St. Paul, Seattle and elsewhere, one of the largest firms of contractors in this country. And the accounting work was in charge of Major Dempsey. Naturally, the organization has gone on increasing, so that the division now comprises about 350 men.

A committee of the National Council for Defense, under the Munitions Board, — of which Frank M. Scott, of Cleveland, was the very able chairman, — known as the Committee on Emergency Construction of Buildings and Engineering Construction, acted in a purely advisory way to General Littell, and suggested this organization which was subsequently appointed by him from civil life. This committee attempted to fill the gap between the time of his appointment and the time when the appropriation bill might be passed by Congress, for at that time General Littell had no funds, no personnel, no place even in which to work, and with the construction of millions of work, in so short a period of time as from three to six months, it was obviously necessary to save every day which could be saved.

This civilian committee consisted of William A. Starratt, of New York, formerly of Thompson, Starratt & Co., chairman; Mr. M. C. Tuttle, of this city, whom most of you probably know as secretary of the Aberthaw Construction Company; Mr. Lundhoff, a contractor of Cleveland; Mr. Frederick Law Olmsted, the landscape architect and engineer of Brookline; and Major Kelley, of the United States Engineer Corps, who was not, however, able to give much time to the work.

That committee in turn appealed to various individuals to assist in this work; and it was in this way that Mr. George W. Fuller, of New York, and I happened to be drawn into the work. We were mere subcommitteemen, doing what we could to help, through our knowledge of engineers and contractors in the country. The principal work — I cannot speak of this at length for lack of time — which that committee did was, first, to send out competent engineers to the sites, as they were chosen by the Army Staff, to make the necessary surveys and study the topography, the water supply, the sewerage and railroad facilities, and so on. That work was taken up and done virtually before the appropriation bill was passed by Congress, without funds, without any assurance that the Government would pay for it, through the voluntary services of men who were the leading men in their respective professions in the several sections of the country involved.

Then the committee took up the question of the form of contract. It was obvious that the ordinary Government method, of competitive contract, was out of the question because of the lack of time and of the fact that a contractor, facing the uncertainty of the labor market and the uncertainty of his ability to get materials, would have had to increase his bid to such an extent as to involve a very serious increase in cost to the Government. There were considered, then, these alternative forms of contracts, lump sum profit and a percentage profit. The former was given up because of the fact that it was believed that it emphasized more the question of the amount of money involved than the fitness of the individuals to do the work, and that it would not result in any cheaper construction than the percentage contract with an up-set limitation in profit. In other words, if the lump sum basis had been selected it would have been difficult for the Government to have taken what it believed to be the most competent man to do the work, if a number of other men had offered to do the work for a less sum.

The committee, therefore, prepared this form of contract, which was known as the "emergency contract," providing for cost, plus a sliding scale of profit depending on the magnitude of the work, with an up-set limit in cost. It did this work with the assistance of many able men, lawyers, engineers, administrators, Government officials; and the form of contract was finally adopted by the Secretary of War and used by General Littell in the work.

The next thing the committee did was to investigate the question of available contractors. Questionnaire letters were sent out to fifty of the leading trunk-line railroads, eighty of the leading engineers and architects of the country, and to various governmental bureaus, and personal telegrams were sent to men who might know about the most available persons. From the results of that call, lists of available firms were prepared, and then there were obtained the records of the contractor's work, the men whom they had handled, the men whom they had fed in camp, the millions of work done and the character of the work done in the last two or three years; and I assure you it was a most inspiring list. We would have had no difficulty in selecting one hundred contractors who could have handled millions of work for the Government in the course of twelve months' time. I think it was a surprise to all of us.

The designation, when the camps were located, of the most desirable contractor to do the work was made by a subcommittee of five, who reported to the Munitions Board, that is to Mr. Scott's committee, which committee then made recommendation to General Littell. General Littell took the recommendation to the Secretary of War, the Secretary of War then passed upon it, and finally General Littell made the appointment. In that way the Government had the benefit of the advice and the suggestions of these bodies of men representing these two committees, and was perfectly free to act as it saw fit on the best information available to it. As matter of fact, the contractors designated were appointed in substantially every case. I think that the construction of the camps has justified the choice and that the contractors chosen have made a splendid record for themselves.

The committee then took up the question of the personnel of the engineer corps to build the various camps, and suggested to General Littell's department the men it thought available at the moment to take up the work, and the appointments were subsequently made by General Littell, of the engineers in that way. It was in that way, for instance, that Mr. Barbour was appointed, the whole theory being to appoint the most competent and available men at the time for the work, men whom it was believed would work well together, so that the Government would get good team play, and then giving them a free hand to do the work on the ground. The work was in fact done in that way; Mr. Barbour, for instance, called to his assistance various men to take charge of the various branches of the work, — the water supply, the roads, sewers, steam plant, and so on, — so that he had a corps of 140 men at one time on his engineering staff. The accounting force was appointed in a similar manner. Suggestions for the latter were made by the Advisory Committee, and the appointments were made by General Littell with the assistance of Major Dempsey, and the accounting force ranged from perhaps 75 to 125 men at the various camps.

Various issues came up in regard to the form of contract. Effort was made to so arrange the method of approving and paying for the work to reduce the difficulties in getting the pay-rolls through promptly, so that the carrying charges should not be unduly burdensome to the contractor. It was very difficult to get concession to this end from the Government. For instance, it was suggested that in view of the dilatoriness of the Government, or from lack of personnel to pay promptly, it would be equitable to allow the contractor interest on the carrying charges. The instant reply was that that would set such a dreadful precedent for the Government that it would cost it millions or billions hereafter, and was not to be thought of. So the unfortunate contractor had to bear that burden. But, on the other hand, every possible effort was made by the comptroller of the currency — who is the final dictator in the Treasury Department — to arrange for the corps of accountants to make the payments as rapidly as possible. But there was required by the contractors at the various camps a working capital of from $750 000 to $1 000 000 to execute their work, which became a burden of expense to the contractor through the fact that the bills were not always paid promptly when they were due.

Just one thing more in closing, to meet the idle comments and criticisms made by thoughtless persons in the press as you hear them from time to time. Bear in mind that this wasn't, and in the very nature of the case could not be, a sandpapered job, and that it could not be done with the same finish and care which would have been exercised if two years could have been taken to build it, instead of only from three to six months. It was a saving *not in cost, but in time and in lives; in the highest sense, an economical procedure;* because you will realize, when you stop to think of it, that if the contractors had been limited in what should be paid for wages, to what should be paid to a permanent force, for instance, it would not have been possible to have gathered together in so short a time an organization of 10 000 men such as there was at Ayer. What was paid for labor was the ruling wage in the several communities in which the camps were built, and that meant the ruling wage for an eight-hour day, with time and a half or double time for excess time. And no amount of explanation would have helped the situation if the contractor had failed to complete the work promptly. Delay in this work, even though it had resulted in some saving of cost here, would have involved millions of loss abroad in this interval, which would have meant that additional months would have been spent on the firing front and additional thousands of lives would have been lost. So it seems to me that the proper perspective, the proper point of view, is that the work was done with a view to saving time, to getting the work done as quickly as possible, that men might be trained in these camps as soon as possible; and that was accomplished.

MR. GEORGE W. FULLER. *Mr. President and Gentlemen,* — I am very glad to have heard Mr. Barbour's address to-day. I am still more glad to pay tribute to the splendid work which he has done for his country, both as a man and as an engineer. It is a simple statement when you hear it said that some six or eight million dollars have been spent in three or four months, but what that means is something that very few, if any of you, really know. The strain which it has meant, physically and mentally, from the standpoint of all the engineering skill at his command, is something which makes me feel very proud of Mr. Barbour, and very proud, also, of what water-works men have done generally in this great response which has been given to the call for help in putting the conscripted men quickly into the cantonments. I am very glad to say I feel just as Mr. Metcalf does about this whole matter, that it has been a very wonderful success in a very large sense of that word. I believe the way that water-works men have been responsive to the demands quickly put upon them at all these cantonments and National Guard camps is a splendid tribute to their loyalty and ability.

The hour is late, and I am not going into details. I simply am very glad to say a word about the splendid work which Mr.

Barbour has done, and I think it is work which has been unsurpassed at any of the cantonments. It is work which was done quickly, and I believe that it was done in the face of difficulties as to topography, wooded area, etc., which have put a great deal more of a demand upon the resources of the men in charge than has been the case at some of the other sites.

RECENT LEGISLATION AND DECISIONS OF THE COURTS WITH REFERENCE TO THE SANITARY PROTECTION OF WATER SUPPLIES.

BY ALBERT L. SAWYER*

[Read March 13, 1918.]

A case prosecuted last year by the Haverhill Water Board, in their endeavor to secure the sanitary protection of the water used by the city of Haverhill as sources of water supply, may be of interest to the members of the Association, especially as it involves a decision of the Supreme Court of Massachusetts affecting the right of the State Department of Health to delegate its authority and of the Water Board to withhold permits, the Court further ruling that the enforcement of these regulations was neither arbitrary nor unreasonable.

Although there have been many decisions made in favor of the State Board in specific cases, this is the first time, I believe, that the right of the board to delegate its authority has been passed upon, and it is considered a most important decision by the State Department of Health, and will doubtless lead to a more vigorous enforcement of rules by many water departments.

The city of Haverhill obtains its water supply from five lakes and ponds and a storage reservoir, all but one situated within the city limits. The approximate distances of these ponds from City Hall is as follows:

Lake Saltonstall	one mile
Round Pond	one mile
Kenoza Lake	two miles
Johnson's Pond	three miles
Millvale Reservoir	three and one-half miles
Crystal Lake	five miles

At the request of the Water Commissioners, the State Department of Health in September, 1901, set forth rules and regulations covering Kenoza Lake and Millvale Reservoir, and in February, 1912, similar rules covering the other ponds. Since this latter date, all boating, fishing, bathing, etc., has been forbidden, and in 1914, skating was also prohibited. Since 1913, an inspector of the watersheds has been employed.

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*Water Registrar, Haverhill, Mass.

Ice cutting is permitted, written permits being issued which contain a list of rules to be observed. There is one large ice company with houses on the shore of one of the lakes, the remainder of the cutting being mostly done by parties harvesting their own supply.

As the question of inconsistency in prohibiting fishing while allowing ice-cutting was brought up, the following extract from the report of the Water Board for 1913 may be of interest as showing the viewpoint of the Board:

" An opinion seems to prevail in the minds of some, that the issuance of permits to cut ice upon the lakes and streams of our water supply is inconsistent with the enforcement of rules and regulations relating to boating and fishing, and some special criticism has been directed against the Board upon this account.

" The essential facts bearing upon the question of ice-cutting seem to be as follows:

" Health authorities inform us that some forms of disease may be communicated through the medium of ice, as well as water, therefore it is generally agreed that impure ice is fully as detrimental to the public health as impure water.

" Ice, though not so extensively used, is absolutely necessary.

" Its purity must, therefore, be safeguarded. To this end our laws provide that the State Department of Health may establish ordinances to secure the inspection of ice sold within its limits and to prevent the sale of impure ice. They are further given, by statute, the general oversight and care of all inland waters and of all ponds and streams that are used not only by any water company but by any ice company; and they may provide for the granting of written permits for the purpose of harvesting ice, etc.

" Acting under the advice of the State Department of Health, this department has endeavored to provide proper supervision of ice cutting. Inspectors are stationed at the different ponds; and are present at all times during ice-cutting.

" The Board has found not only the two local companies, but the few individuals who harvest their own supply, willing and apparently anxious to comply with the rules and regulations imposed.

" The Board are prepared to still further restrict ice-cutting and even stop it altogether, whenever they feel that the health of the water takers or the purity of the water supply demands such action. At the present time, however, with the supervision above referred to they believe that they are acting with due regard to the letter and the spirit of the law and are carrying out the policy of the State Department of Health.

" The board is of the positive opinion that reasonably pure ice can be supplied to our citizens, from our own lakes and streams if cut under careful supervision, and therefore deems it wiser to issue permits as heretofore, than to refuse such permits and force our public to procure ice from sources of which we have no knowledge and over which we can have no supervision."

The enforcement of the rules and regulations has received the endorsement of the local board of health and, I think, of a majority of our citizens. Of course all this provoked much opposition from the fishermen, and particularly from a local sportsman organization.

We knew that there was more or less fishing going on, but it is difficult to get the evidence that will convict.

During the last four years there have been six prosecutions for bathing; three for boating; seven for fishing, and one for not having a proper cesspool. Convictions were secured in the local court in every case but one.

A Mr. Hyde had openly boasted about the city that he fished when he pleased, and that the board could not stop him. We were aware of the fact that he fished, but had hitherto been unable to get direct evidence.

January 2, 1917, our inspector was on duty at one of the ponds where ice-cutting was going on, and, as we were having some trouble in keeping the pond clear of skaters, a special officer was on duty at the same place. I received a telephone message from a resident at Crystal Lake that several persons were fishing through the ice at Crystal Lake. We immediately sent our light truck to the pond, picked up our inspector and the policeman, and in half an hour they were at Crystal Lake, where they found Mr. Hyde with a full complement of lines through the ice, and a fine mess of fish on the surface of the lake. It was quite an interesting session for a few minutes, but he realized he was taken with the goods.

A complaint was sworn out, and in the local court a fine of ten dollars was imposed, and an appeal taken to the Superior Court.

Here it went before a jury on an agreed statement of facts.

The legal history of the case follows:

THE COMPLAINT.

COMMONWEALTH OF MASSACHUSETTS.

Essex, ss.

Frank S. Reed in behalf of the Commonwealth of Massachusetts, on oath, complains that Fred H. Hyde of Haverhill, in said county, on the second day of January, in the year of our Lord nineteen hundred and seventeen, at Haverhill, in said county, did then and there go upon the ice of Crystal Lake, so-called in said Haverhill, and did fish in said lake, without a written permit to do so of the Board of Water Commissioners of the said city of Haverhill, in violation of the Rules and Regulations of the State Board of Health of the said Commonwealth against the peace of said Commonwealth, and contrary to the form of the laws in such cases made and provided.

He, therefore, prays that said defendant may be arrested and brought before the said Central District Court of Northern Essex, in said county, and held to answer to this complaint, and further dealt with, relative to the same, according to law.

FRANK S. REED.

Received and Sworn to this third day of January, in the year of our Lord one thousand nine hundred seventeen.

Before said court.

A. Franklin Priest, *Clerk.*

AGREED STATEMENT OF FACTS.

The defendant was complained of in the Central District Court of Northern Essex for going upon the ice of Crystal Lake, so called, in Haverhill, in said county, and fishing in said lake without the written permit to do so of the Water Commissioners of the said city of Haverhill, in violation of the rules and regulations of the State Board of Health of the Commonwealth. A copy of the State Board of Health Rules and Regulations in question is hereto annexed and made a part of this agreed statement, and it was a violation of Section 13 of said rules and regulations which was complained of.

On the 2d day of January, 1917, the defendant, who was a resident of Haverhill and engaged in the business of a real estate broker, went fishing upon Crystal Lake, which was at that time covered with ice, and while so fishing through holes cut in the ice was arrested. He had that day asked for a permit from said Water Commissioners to fish through the ice on said lake but was refused such permit. He was willing to conform to any reasonable requirement to obtain such permit. Permits had been given to cut ice on the same lake for sale to the public. The defendant was within the law relating to the number of lines to be used in fishing, and was also observing the law in regard to the number of fish caught.

The water of said Crystal Lake is used as a source of water supply for the City of Haverhill, and is a great pond about five miles from the center of the city

LOUIS S. COX,
District Attorney.

Filed October 15, 1917.

HUBERT C. THOMPSON,
Attorney for Defendant.

REPORT OF CASE.

The above-entitled case was tried before me at the September sitting of the Criminal Court at Salem, upon an Agreed Statement of Facts filed herewith.

Upon the said Agreed Statement of Facts I instructed the jury that they would be warranted in returning a verdict of " Guilty," to which the defendant duly excepted.

The jury returned a verdict of " Guilty." The District Attorney moved for sentence. Whereupon I imposed a fine of $10.00.

Being of the opinion that the question raised by the above exception ought to be determined by the full Court, and at the request of the defendant, I report the case for the determination of the Supreme Judicial Court.

Upon motion of the defendant, execution of the sentence was stayed pending the determination of the question raised.

If the ruling was right the verdict is to stand, otherwise a new trial is to be granted the defendant.

Filed December 19, 1917.

HUGO A. DUBUQUE,
Justice of the Superior Court.

DEFENDANT'S BRIEF.

STATEMENT OF THE CASE.

The Rules and Regulations of the State Board of Health indicate that in the city of Haverhill at least four lakes and ponds are set apart for the water supply of the city. Of these lakes and ponds Crystal Lake is about five miles from the city proper. The Water Commissioners, acting under the authority of the State Board, refused a permit to the defendant, under any circumstances, to go upon the ice and fish; and by the same authority granted permits to others to go upon the lake and cut ice. There was no evidence of pollution of the water by the defendant, or that the defendant did not take every precaution to prevent any pollution of the water.

ARGUMENT.

Before the enactment of the Amendment of 1907, giving power to the State Board to delegate its authority to the local boards, it was decided by this court that the State Board could not delegate such authority, under Revised Laws, Chapter 75, Section 113, Commonwealth *v.* Staples, 191 Mass. 384. The above amendment following this case undoubtedly made valid such delegation, and a proper adhesion to the Rules and Regulations of the State Board by the local board has the same effect upon the general public as an act of the State Board itself.

In this case it must be remembered that the defendant is brought into court against his will. There is a marked difference between a party plaintiff who sues by civil means to obtain his rights and one who is complained of for committing a criminal act. (Stevens *v.* Casey, reported 29 October, 1917.) In the latter case the petitioner had not exhausted his remedies, while in the case at bar the defendant " can invoke protection from the court against the entire proceeding." The provision of 1907, giving a right of appeal to the State Board, was remedial in its nature, in favor of a defendant, and not a necessary step to be taken before he can offer a defense to a criminal complaint. (Stevens *v.* Casey, above.) Certainly the Commonwealth acquired no advantage by the defendant's failing to use an appeal from the constituted authorities of the Commonwealth. It follows that the acts of an agency such as the Water Commissioners, in following the Rules and Regulations of the State Board, have the same force as the acts of the State Board.

The combined action of both agencies of the Commonwealth had the practical effect of making a prohibition of the act of fishing through the ice. The facts in this case are similar in temper, at least, to those in Austin *v.* Murray, 33 Mass. 121, where a regulation amounting to a prohibition was declared void. The defendant contends that the act of fishing is capable of restrictions within its own class, and that a prohibition of the act under any conditions was never contemplated in the authority granted in Revised Laws, Chapter 75, Section 113, or its amendments, and was therefore arbitrary and unreasonable.

Again, it is admitted by the authorities that cutting ice was allowed by a permit under the same rules and regulations. In so doing the defendant was placed in an unjust and unreasonable classification. " While reasonable classification may be made in the interests of public health, public safety and public morals, yet there must be some rational relation between the object to be obtained and the classification in order that it may not violate the constitutional guaranty that all persons, including corporations, shall be equal in the protection afforded by the laws." (See Opinions of Justices, 220 Mass. 631.)

HUBERT C. THOMPSON,
For the Defendant.

COMMONWEALTH'S BRIEF.

STATEMENT OF THE CASE.

The defendant in this case was complained of, as stated in the Agreed Statement of Facts, for violating rules and regulations promulgated by the State Board of Health in accordance with Chapter 75 of the Revised Laws, Section 113, as amended by the Acts of 1907, Chapter 467, which reads as follows:

> " Be it enacted, etc., as follows:
>
> " *Section 113.* Said board may cause examinations of such waters to be made to ascertain their purity and fitness for domestic use or their liability to impair the interests of the public or of persons lawfully using them or to imperil the public health. It may make rules and regulations to prevent the pollution and to secure the sanitary protection of all such waters as are used as sources of water supply. Said board may delegate the granting and withholding of any permit required by such rules or regulations to state boards and commissions and to selectmen in towns and to boards of health, water boards and water commissions in cities and towns, to be exercised by such selectmen, board and commissioners, subject to such recommendation and direction as shall be given from time to time by the state board of health; and upon complaint of any person interested said board shall investigate the granting or withholding of any such permit and make such orders relative thereto as it may deem necessary for the protection of the public health.
>
> " *Section 2.* This act shall take effect upon its passage.
>
> " Approved May 29, 1907."

There was no question raised at the trial as to the form and promulgation in due course of the Rules and Regulations of the State Board of Health, which are made a part of the Agreed Statement of Facts, and there was no question but that the Board of Water Commissioners of the city of Haverhill was the board in control, on the date that the defendant was complained of, over the water supply of that community and of the water of Crystal Lake. Neither was there any contention at the trial, and it is conceded, that the defendant did not make any complaint to the State Board of Health after his request for a permit from said Water Commissioners had been refused. The defendant was merely a resident of the city of Haverhill, and claimed no rights of ownership about or around the waters of Crystal Lake.

ARGUMENT.

1. The contention of the defendant in this case, by inference from the Agreed Statement of Facts, must be that the Board of Water Commissioners of the city of Haverhill, in refusing him the written permit provided by the Rules and Regulations of the State Board of Health, acted unreasonably, arbitrarily, and invaded inherent statutory rights possessed by individuals to use great ponds for fishing. The answer to this, the Commonwealth submits, is that the defendant has not exhausted the rights given to him by

the legislature; and that he did not, when he felt himself aggrieved, file a complaint with the State Board of Health, as provided in the Acts of 1907, Chapter 467. In other words, he cannot now complain if the rules, under which he was convicted, are proper.

Stevens *v.* Casey (Department Reports, 655). 29 October, 1917.

2. But the Commonwealth further contends that, on the assumption that the action of the board is arbitrary, an individual citizen has no appeal to the courts in a matter of this kind where the legislature has entrusted quasi-legislative functions to the State Board of Health and local boards under its jurisdiction.

The Court said, in Nelson *v.* State Board of Health, 186 Mass. 330 at 335, speaking of rules adopted by the State Board of Health (under Statute 1897, Chapter 510, Section 1, which act was incorporated in the Revised Laws, Chapter 75, Section 113, in issue here), " We are of the opinion that rules adopted by the State Board of Health under Statute 1897, Chapter 510, Section 1, are quasi-legislative."

This Court has already said, referring to a state administrative board, in Com. *v.* Sisson, 189 Mass. 247 at 252, which was a stronger case for the defendants, in that they were private owners of land adjoining the pond, where it was sought to protect fishing, that " no more than in the case of the legislature itself is it bound to act only after a hearing or to give a hearing to the plaintiff when he asks for one; and its action is final, as is the action of the legislature in enacting a statute. And being legislative, it is plain that the questions of fact passed upon by the commissioners in adopting the provisions enacted by them cannot be tried over by the court."

The Commonwealth submits that the reasoning underlying the above quotation applies, with equal force, to the action of a local board in refusing to issue a written permit to fish in the waters of a great pond reserved for water supply, without giving reason therefor. " The remedy is by application to the legislature, if a remedy should be given." See Com. *v.* Sisson, 189 Mass. at 254.

LOUIS S. COX,
District Attorney, Eastern District.

THE DECISION.

ESSEX. FEBRUARY 9, 1918.

COM. *v.* HYDE.

WATER SUPPLY — PROHIBITION OF FISHING BY MUNICIPALITIES WITHIN POLICE POWER IN ORDER TO MAINTAIN PURITY OF WATER.

RUGG, C. J. — This is a complaint charging the defendant with going upon the ice of Crystal Lake and fishing therein without a written permit of the water commissioners of the city of Haverhill, in violation of Rules and Regulations of the State Board of Health. The pertinent part of the regulation of the State Board of Health is as follows:

> "No person shall . . . unless permitted by a written permit of the board of water commissioners of the city of Haverhill fish in . . . Crystal Lake . . . so called in the city of Haverhill . . . said lakes . . . being used by said city as sources of water supply."

The regulation was passed pursuant to Revised Laws, Chapter 75, Section 13, as amended by Statute 1907, Chapter 467, Section 1, which empowers the State Board of Health to "make rules and regulations to prevent the pollution and to secure the sanitary protection of all such waters as are used as sources of water supply," with power to delegate the granting or withholding of permits to water commissioners, subject to investigation and revision by way of appeal to the board itself.

The delegation by the legislature of the right to make rules and regulations is within its power. (Com. *v.* Sisson, 189 Mass. 247. Com. *v.* Kingsbury, 199 Mass. 542.) The case at bar thus is distinguished from Com. *v.* Staples, 191 Mass. 384, where no power of delegation was conferred by the statute there under consideration. The power of revising the conduct of the water commissioners reserved to the State Board of Health by the statute avoids the difficulty of vesting an untrammeled discretion in a subordinate board or officer, which was held fatal to the ordinance before the Court in Com. *v.* Maletsky, 203 Mass. 241; Goldstein *v.* Connor, 212 Mass. 57; Stevens *v.* Landowner, 228 Mass. 368. The regulation passed by the State Board of Health in pursuance of the statutory authority, prohibiting fishing upon a body of water used as a source of water supply for a municipality, cannot be pronounced unreasonable. It requires no discussion to demonstrate that the preservation of the purity of the water supply for the domestic uses of the people is within the police power. The absolute prohibition of fishing upon such a source of supply could not be said to be unreasonable under circumstances here disclosed. It is not irrational for a public board to deem it likely or possible that sources of contamination and germs of disease might have a casual connection with the presence of fishermen upon the ice or waters of a supply of drinking water. (Nelson *v.* State Board of Health, 186 Mass. 330. Sprague *v.* Minor, 195 Mass. 581.) The case of Austin *v.* Murray, 16 Pick. 121, upon which the defendant relies, is quite distinguishable.

LOUIS S. COX,
Attorney for Commonwealth.

HUBERT C. THOMPSON,
For Defendant.

The decision of Justice Rugg was given February 9. Our local paper of the 14th contained the following information:

"In the Superior Criminal Court before Judge Dubuque at Salem, Fred H. Hyde, who had been found guilty of a violation of the regulations of the

State Department of Health, was fined $10.00. George Picard and George Walsh, whose appeals were pending on similiar charges, plead guilty and were each fined $5.00."

The State Department of Health have now sent the following letter to every water board in the state:

"It having come to the notice of the State Department of Health that permits are being granted for fishing in some of the bodies of water used as sources of public water supply, and that much pressure is being brought to bear in many places for the granting of such permits on account of the alleged desirability of taking the fish for the purpose of increasing the food supply, the Department takes occasion again to call attention to the great danger to the public health that is likely to result from this practice. The investigations of the Department have shown that, where fishing is permitted, pollution of the water inevitably results, and the danger that polluting matters deposited by fishermen or others upon or in the neighborhood of reservoirs used as sources of water supply may enter the pipes and cause injury to health is, in its opinion, most serious.

"The Department recommends that no permits be given for fishing in any body of water used as a source of public water supply from which water is taken directly for drinking, and that no fishing be permitted in tributary sources, unless advised by this Department, and then only under such limitations and restrictions as the Department shall recommend.

"Your attention is called to a recent decision of the Supreme Court in a case at Haverhill relative to the prohibition of fishing by municipalities in order to maintain the purity of water used for drinking. A compared copy of this decision is appended hereto.

"By order of the State Department of Health,

"A. J. McLAUGHLIN,
"*Commissioner of Health.*"

DISCUSSION.

THE PRESIDENT. The paper is now open for discussion or the asking of questions. The program this afternoon seems to me to illustrate the great variety of subjects with which water-works men have to be familiar. We have had geology by Mr. Fitzgerald, electricity and water power by Mr. Coggeshall and Mr. Mendell, and now we come down to legal questions and public-health questions, all of them very vital and everyday matters.

MR. PERCY R. SANDERS.* We have had a case in Concord, N. H., on our water supply. Our Board got up rules and regulations similar to those Mr. Sawyer, of Haverhill, has read to you, and the public took exception to some of the rules. We didn't go so far as to prohibit boating and fishing all over our lake, but we prohibited it one-quarter of a mile from our intake.

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* Superintendent Water Works, Concord, N. H.

Our water supply is taken from two connecting ponds, Long Pond, or Penacook Lake, and Forge Pond. Penacook Lake is two miles long and one-half mile wide at its widest point, with an area of 338 acres; Forge Pond is a small body of water at the outlet. When the works were built, in 1872, the city built a dam about one-half mile down stream from the old outlet, raising the height of water about six feet and flooding an additional area between the old outlet and the new dam, increasing Forge Pond to 30 acres.

When our rules and regulations for the sanitary protection of our supply were adopted in 1915, all boating and fishing were prohibited on Forge Pond in addition to the quarter of a mile from the intake in the lake. As this was the most accessible approach to Penacook Lake and most of the landings and moorings were there, the effect of the regulation was to stop the boating from this end and thus nearly all boating anywhere on the lake.

One owner took exception to the regulation. He owned a steamboat and he refused to take his boat from the closed part of the lake. We gave him a certain time in which to do it and when he didn't comply with our order we took his boat to the upper end of the lake and notified him that he could take care of it. He didn't do so, — I suppose he left it with the idea that he could collect damages from us. He then brought suit against us to have his privileges restored to him. The case came to trial in the Superior Court, and the judge upheld us in all our rules and regulations, deciding that they were fair and reasonable, and that this man had no right to run his boat on the prohibited part of the lake. He owned no land where his wharf was built. The judge ruled for us on every question that we asked him to rule on, — that these rules were made for the protection and care of the supply. The man and his friends were so disheartened at the decision that they didn't carry the matter to the Supreme Court. Of course we would have felt better satisfied if it had gone to the Supreme Court, but I think that they felt, by the judge granting every one of our requests, that there would be absolutely no chance for them.

We had another case, two or three years before this, with this same man, and he lost out at that time. I think the fact that he lost in both cases rather took his courage away, so he thought that he had spent about money enough, and wouldn't carry the matter any further. It seems to me that this shows that the Courts are willing to grant us about anything we ask for that is reasonable for the protection of our supplies. The first time we were before the court the judge made the remark that if any child or any person should become ill by reason of the boating, he would always feel that he had neglected his duty. And I think that is the opinion that Courts all have.

MR. WILLIAM F. SULLIVAN.* I wish our lamented friend Walker was here, but his successor is here, and perhaps he can tell us how Mr. Walker, in the absence of law and regulations, became judge and jury and court and everything else, and when he couldn't regulate the use of Massabesic Lake in any other way he went over there and destroyed camps and was denounced and almost hanged for it.

MR. MENDELL. Mr. Walker sometimes took things into his own hands, and he burned up several camps that had been more or less complained about. He also did another thing, which I think may interest you. The Manchester Coal and Ice Company cut their ice on Massabesic Lake, and he made them furnish to every fifty men an iron receptacle which they would take on to the ice in the morning and take off and empty over five hundred feet from the shore every night. If it was frozen up, they had to thaw it out and clean it. Fishermen bother us more than the ice cutters, because they are here and there all over the lake, and it keeps men all winter looking after them.

MR. SULLIVAN. Did the owners prosecute Mr. Walker?

MR. MENDELL. Yes, they did. We didn't want it to get to court, so the Commissioners and Mr. Walker chipped in and we paid for it out of our own pockets.

MR. SAWYER. Personally, I am not in favor of allowing ice cutting, but the position our water board has taken in regard to that is that the ice cutting is done in a restricted area and can be watched. If you allow fishing and skating on the ice it is impossible to have inspectors enough to follow it up, but one or two inspectors can look after the ice cutting. We have seen a good many articles in the paper, this winter and in other years, about different lakes which are open for fishing and one thing and another, and I have taken pains to follow up every case I have seen in the papers, and in almost every instance I find that the facts have been misrepresented. Incidentally I might say that the game and fish commissioners in Massachusetts apparently do not work in conjunction with the State Department of Health. A representative of the Fish Commission, speaking some time ago in Haverhill, claimed that it was a good thing to allow fishing, and he instanced the city of Springfield, where indiscriminate fishing was allowed. I wrote to Mr. Martin, and he said that the man was partially right, that they did issue permits for fishing in the part of their system which supplied Ludlow, ten miles from the city of Springfield, but they had discontinued that part as a source of supply for Springfield. Then there was another article which said that they were allowing fishing in Natick. The superintendent informed me that they were allowing fishing there, but it was on the Metropolitan system, and that Natick didn't take the water from the pond but took it from wells. A few weeks ago it was said that they were issuing permits for fishing in the Avon reservoir in Brockton, but I am told that that reservoir is not used for a water supply at all, but simply as a storage reservoir. I also had my attention called to the conditions in Manchester, where fishing was allowed, and I wrote to Mr. Mendell, who said that they didn't believe in it up there, but I received the impression that they hadn't quite got the courage of their convictions to stop it.

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* Engineer and Superintendent Pennichuck Water Works, Nashua, N. H.

MR. MENDELL. They have the spirit but not the power.

MR. CHARLES R. WOOD.* This talk on fishing is interesting, because the United States Government has exempted from the draft a certain number of agriculturalists, and a good many people in South Jersey at the present time are very much worried to know whether a clam digger is a fisherman or a farmer.

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* Of R. P. Wood & Son, Pipe Manufacturers. Philadelphia, Pa.

[*Laughter.*] I wish somebody might give me some information on that point.

MR. SIDNEY SMITH.* I will give you an answer from New Jersey. A clam digger is neither a fisherman nor a farmer; he is a miner. [*Laughter.*]

MR. PATRICK GEAR.† I want to give a benediction from Holyoke. A couple of years ago I rode out to the pond one day and I found some men there fishing through the ice. I asked them if they caught any short fish what they did with them? They didn't know. I said, "You know the rule is that we don't allow you to throw them back into the water, for they will die after they have been hooked." Well, I was talking with these fellows about it, and they showed me a place over in a corner on the shore where they were frying a few short ones, and they asked me over to lunch. I went over with them, and just then three great, healthy chaps came along and jumped over the fence from different sides of the road and came up to us and showed their badges, and they were fish and game wardens. So they looked around to see how many fish there were, and they were within the number allowed by law. Then they looked the fish over to see if there were any short fish. I asked if they caught any short fish what they should do with them, and they said, "Throw them back into the pond." But I said, "No; I won't let them. If they throw them back into the pond I will arrest them." So I said to the wardens, "What are you going to do about it?" And one of them said, "I don't know. I can't arrest them when they are on this pond," for while it is a great pond the city of Holyoke was given control of it seven or eight years ago by the state. He said he couldn't arrest them if they had short fish, while they were on the pond, because we controlled it but if they got on the road he could arrest them. We never settled what would become of the fishermen who caught short fish; he wouldn't let them keep them out and I wouldn't let them put them in. [*Laughter.*] Later the warden sent us a letter and advised stopping fishing altogether through the ice. We did stop it except three days a week, but we have never settled yet what to do with the short fish. If we stop fishing entirely we will put one of their nice jobs out of business, and that is the fish hatchery, because they put trout in the brooks and they won't let us fish in the brooks, and if we won't let them fish in the pond the hatchery will have to go out of business.

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* Civil Engineer, Boston, Mass.

† Superintendent Water Works, Holyoke, Mass.

MR. SAWYER. We have a mayor in Haverhill, at the present time, who is much in favor of fishing, and I am sorry to say that the matter is getting to be somewhat of an issue in the election of water commissioners. It has been reported that the member whose term expires next May can be reëlected by the Municipal Council provided he will vote to open one of the ponds for fishing, but if he does not he is doomed for decapitation.

THE PAST AND PRESENT PUMPING EQUIPMENT OF THE MANCHESTER PUMPING STATIONS.

BY JAMES H. MENDELL.*

[*Read March 13, 1918.*]

Mr. President, Guests, and Members of the New England Water Works Association, — The paper I shall read is a history of the past and present pumping equipment of the city of Manchester, N. H., but first I want to call your attention to my predecessor, the late Charles K. Walker, who was known to many of you. Mr. Walker began his services with the Manchester Water Works in 1873, was elected superintendent in 1875, and retired on April 1, 1912, giving to the city a continuous service of nearly forty years and leaving a record which few if any of us will ever equal, for it is said of him that the city of Manchester was never without its water supply for a single hour during his long term of service, and to his efforts are due many of the improvements which have been made in our pumping equipment.

Who first conceived the idea of a public water supply for the city of Manchester I do not know, as the first records we have are in the year 1868, when the city councils voted to have surveys, plans, and estimates of costs made of several different sources of supply. This took about three years, and Lake Massabesic, our present source of supply, was decided upon. The wisdom of this choice is apparent to-day to every thinking citizen of Manchester, for it is estimated that this supply is ample for a city of 250 000 inhabitants, and in quality is unsurpassed by any city in New England.

This lake lies about four miles east from City Hall, has a surface area of 2 500 acres with a varying depth from a few feet to over two hundred, a watershed of 40 square miles, and a shore line of over 25 miles, 85 per cent. of which is owned and controlled by the water department.

The water supply at the present time is pumped from two stations, known as the low- and high-service. The water from the low service is pumped into a reservoir, from which the water flows, by gravity, through the distribution system, giving a pressure at City Hall of about 60 lb. This station was built in the years 1871–72 near the outlet of the lake, located at an elevation sufficiently low to enable water-power to be used for pumping. The water was delivered through an open canal and 600 ft. of 72-in. wooden stave penstock, with a head of 45 ft. This penstock was in use for forty-one years, being replaced in 1913 with one of steel.

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* Superintendent Water Works, Manchester, N. H.

This station was equipped with one Wood vertical, quadruplex, single-acting pump, having a rated capacity of 5 000 000 gal. in twenty-four hours, connected to 2 vertical 36-in. water-wheels, which furnished the power to operate this pump, using 7½ gal. of water to each gallon of water delivered into the reservoir. For the first three years it was only necessary to run this pump from three to five hours every other day. From that time until 1886, it was run every day, first about three hours and gradually increasing to eight.

In 1886, it became necessary to make extensive repairs to the water-wheels and pump, and two vertical 36-in. Risdon water-wheels were installed to replace the old ones, also a Davidson horizontal, duplex, double-acting pump, having a daily capacity of 5 000 000 gal. The power for operating this pump was communicated from the old jack shaft in such a manner that the pumps could be operated separately or together. As the Davidson pump would deliver one fourth more water into the reservoir with the same amount of water used, the old Wood pump was only used in case of emergency.

This equipment furnished the supply until 1893, but for several years before this the water commissioners had decided that the rapid growth of the city would make necessary the installation of another system where higher pressure could be maintained. Plans were made in 1890, and work began in 1891, upon what is now called our high-service system. The station and reservoir were finished in 1892, but the water from this system was not used until early in 1893.

This station was located about two miles from the low-service station, near the lake shore, the water supply taken from a point

250 ft. from the shore of the lake through a 24-in. cast-iron pipe into a well underneath the station. The station was equipped with two Worthington steam pumps, having a daily capacity of 3 000 000 gal. each, a suction lift from 9 to 15 ft., pumping against a head of 290 ft. The steam to operate these pumps was furnished by two 150 h.p. Manning-type unright boilers. The water was pumped directly into the system with an equalizing reservoir for use when the pumps were not running. The distribution system was divided, and only the highest elevations were supplied from this station. The running time, until 1895, was from five to ten hours every other day, when more of the distribution system was taken from the low service and added to the high service, making it necessary to pump every day from eight to twelve hours. In 1900, an addition was built to this station for the purpose of installing a Snow pumping engine with a daily capacity of 6 000 000 gal. The steam for this pump was furnished from the 150 h.p. boilers, which were used for this purpose until 1910, when they were exchanged for two 250 h.p. boilers of the same type. During this time the old Worthington pumps were only run two days each month, or, in other words, only enough to keep them in condition for use in case of emergency.

In the fall of the same year, a one-story addition was built to the low-service station, in which was installed a 6 000 000-gal. single-stage DeLaval centrifugal pump with a direct connection to a 200 h.p. motor. The power for this motor was furnished by the Manchester Traction, Light and Power Company at a cost of 2½ cents per kw.-hr. This increased the cost of pumping from $3.00 per million gallons, by the old water pumps, to $18.20 per million gallons by the centrifugal pump, and for the reason of this high cost the electrically driven pump was only used in periods of extremely low water.

In 1913, the consumption of water was so much greater that the water pump had to be run fourteen hours per day to supply the demand. For this reason it was deemed best to make some changes at this station, and after several plans had been made it was decided to use the water-power for the development of electricity. This necessitated the removal of the old water-power pumps, which were sold as junk, and in 1914 a pair of 250 h.p. Trump turbine water-wheels, directly connected to one 375 kw. generator, were installed. During the period of this installation, the centrifugal pump was run by power furnished by the Manchester Traction, Light and Power Company. With this equipment completed we had sufficient power to operate the 6 000 000-gal. centrifugal pump at the low-service station and a 3 000 000-gal. centrifugal pump at the high-service station, a transmission line having been run between the two stations; and all of the water pumped into both the high- and low-service reservoirs, for ten months in the year 1914, was by power furnished by the new electric development at the low-service station.

This equipment proved so satisfactory that the following year it was decided to develop electricity by steam at the high-service station, so that all pumping could be done with electrical power. For this purpose two electrically driven centrifugal pumps were purchased, a 5 000 000-gal. for the high service, and an 8 000 000-gal. for the low service, together with a 1 000-kw. steam turbine generator, and the necessary auxiliary apparatus. To make room for the new machinery at the high-service station, the old Worthington pumps were removed and the room from which they were taken remodeled to fit the new equipment, the installation of which was completed in October, 1917, and has been in operation since.

We are very fortunate in our sources of power supply, being connected with the power plant of the Amoskeag Manufacturing Company, the Manchester Traction, Light and Power Company, in addition to our own water and steam supply. With these four different sources of power with which to operate, we believe we have to-day the very last word in electrical apparatus for the operation of electrically driven pumps.

Fourteen million gallons can be pumped at the low-service station, and 8 000 000 gal. at the high-service in twenty-four hours, with the electric pumps, with the 6 000 000-gal. Snow pumping engine in reserve at the high-service station, making a total pumping capacity of 28 000 000 gal. per day. With this equipment, situated as it is in two different stations, it is hard to conceive of conditions such that the city of Manchester could not be supplied with water.

A LOG BOOK FOR AN ELECTRICALLY DRIVEN PUMPING UNIT AT NEW BEDFORD.

BY R. C. P. COGGESHALL.

[*Read March 13, 1918.*]

The Little Quittacas Pumping Station, which is furnishing the entire supply to the city of New Bedford, is equipped with two compound beam and fly-wheel engines of the well-known "Leavitt" type. They are in duplicate, and each has a capacity of pumping 10 million gallons in twenty-four hours. They have been in commission since 1899. The population supplied at that time was 58 000, and the average daily consumption was 6 300 000 gal. Last year the population reached 115 000, and the average daily consumption was 9 200 000 gal. Since the installation of the engines at the Quittacas Station, they have been operated alternately, but never together, until July of last year. There have been occasions in the past when the aggregate of several days' consumption was in excess of pumping capacity of one engine, but, hitherto, of such short duration that the compensation provided by the distributing reservoir has enabled one engine to provide the necessary amount by pumping continuously for several successive days.

The consumption of 1917 required the reinforcement of the second engine occasionally during "peak loads" periods. These occasions, however, were of short duration, and only a portion of the full capacity of the second engine was required.

As the result of considerable study it was finally decided to install one five-million gallon DeLaval, electrically driven, centrifugal unit. This may be used alone, or in connection with one or both steam pumps.

When used alone, it will pump 5 million gallons in twenty-four hours; in connection with one steam pump, 15 million gallons in twenty-four hours; and in connection with both steam pumps, 25 million gallons in twenty-four hours.

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* Superintendent Water Works, New Bedford, Mass.

The current necessary to operate this unit is to be supplied from the plant of the New Bedford Gas and Edison Light Company, who will furnish same at the Quittacas Station upon the kilowatt-hour base. As this unit does not require the operation of a boiler at the Quittacas Station, this unit may be put in service during holidays or Sundays, when it is desirable to shut down the steam plant.

Many of the electrically driven centrifugal pumps installed in late years are operated by power purchased of some public utility plant upon kilowatt-hour base. Such is New Bedford's case.

The various steam pumping plants with which the speaker is familiar have a complete record of their pumping operations from their very beginnings. The items entered therein and the stated duties are given in accordance with the recommendations and formulæ prescribed by the New England Water Works Association. These duty formulæ (Fig. 1,) give the number of million foot-pounds elevated per one hundred pounds of coal consumed.

In case of steam plants, the exact weight and cost of coal delivered at pumping station boiler is easily determined. This is, however, not true of an electrically driven pump operated by current purchased upon kilowatt-hour base. The best expression in million foot-pound duty to cover this last-named condition is obtained by substituting " kilowatt-hours " in place of " total fuel consumed " in the well-known N. E. W. W. A. formulæ.

The duties obtained by using coal in one instance and kilowatt-hour in the other produce results that greatly differ and that cannot be compared, but all results based on the kilowatt-hour can be compared. The same is true where the coal consumed is the base.

I have been unable to locate a log book for electricity operated centrifugal pumps which supplements the ideas conveyed by the records of the steam units of same station, so I have undertaken the design of such a book, and herewith present reproduction of a page. It explains itself. The required data is easily obtained in our case.

A Venturi meter upon the delivery pipe, just outside the pump house, records the gallons pumped. This may be checked by use of measuring weir in distributing reservoir gate house, eight

PLATE I.
N. E. W. W. ASSOCIATION.
VOL. XXXII.
COGGESHALL ON
A LOG BOOK.

FIVE MILLION e month of

	GAGES.		et.			
r of ns ed.	Ammeter.	Suction.	Reservoir.		Static Head.	Dynamic Head.
ırs.		Feet.	6 p.m.	12 mid.		

y=Number Gallons Pumped (

Total kilowatt hours (

FIVE MILLIO

	SUPPLIES.			
rs.	Oil.	Grease	Waste	Number o Revolutio per Minut

miles distant. The dynamic head is recorded from the readings of pressure gages and mercury column. The watt meter records the kilowatt-hours. In making up duty formulæ, substitute " kilowatt-hours " in place of total fuel consumed.

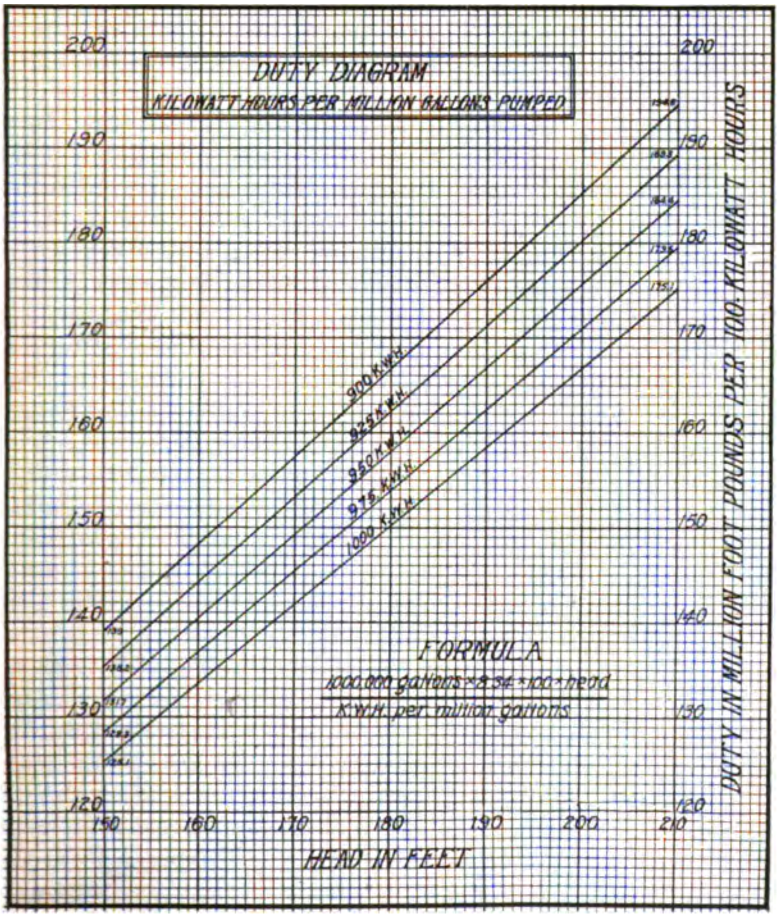

FIG 1. DUTY DIAGRAM.

I am also showing a diagram by means of which the approximate duty may be quickly determined for short runs without resort to many figures.

DISCUSSION.

THE PRESIDENT. I suggest that Mr. Mendell's paper and Mr. Coggeshall's paper be discussed together. This is what we hope to be but the beginning of a more or less continuous program of papers and discussion on pumping-station power, beginning with Mr. Doane's paper last month, and, perhaps, culminating at the annual convention.

A MEMBER. I should like to ask the gentlemen what they have to pay per kilowatt-hour.

MR. MENDELL. We are paying to-day 2¼ cents per kilowatt-hour. The price has been reduced a quarter of a cent since we have made our own development. We think we can develop it by water for a little less than three-quarters of one per cent. The cost of the development by steam I am unable to give you, because the time has been so short and the conditions have not been practicable for making a test.

MR. EDWIN C. BROOKS. Has Lake Massabesic storage enough to run wheels for constant pumping?

MR. MENDELL. In 1914, we pumped all the water by water-power. In an ordinary year we pump from eight to nine months, but you remember that 1914 was quite a wet year. We have another water-power which we hope to develop this year or next, and that will give us something like 300 kw. more, which will give us all the power we shall need for several years.

MR. COGGESHALL. In reply to the gentlemen's question as to cost, I will say that we know it is going to cost us a good deal more than steam, but the more electricity we take the less the rate is going to be. Our object now is to take care of the peak load, the overload, and the electrically-driven unit will probably be used but very little during the next few years, because we have ample power, most of the time running with one engine. It will only be used when we want to help out.

MR. MENDELL. I infer from what you say that the Electric Company will make a sliding price scale.

MR. COGGESHALL. Yes, they will.

A MEMBER. I understand you will not use steam at all in Manchester, except in an emergency?

Mr. Mendell. No, not at all.

A Member. You wouldn't do away with steam altogether?

Mr. Mendell. We would if we didn't have this Snow pumping engine, which is comparatively new.

Mr. George F. Merrill. I should like to inquire if it can be ascertained what the efficiency of the Manchester plant is, as the power is generated by steam and then passed through the centrifugal pumps.

Mr. Mendell. The loss is very small, being connected as we are with our pump right in the same room with our wheel development. Our wheels develop about 85 per cent. of their rated capacity, and there is something less than 2 per cent. lost in going through the switchboard and the motor. On the transmission line we lose about 10 per cent., crossing from one station to the other.

Mr. John C. Chase. I was much interested in Mr. Mendell's paper as showing the changes which have taken place in about half a century. While there are several points in connection with the beginning of the Manchester water works that I might like to elaborate, it is hardly the time to do it in connection with a paper devoted entirely to the power plant. I happen to be, with possibly one exception, the only survivor of the engineering force of that early period. My connection with the water supply of Manchester began in the fall of 1869, in making the survey for the old Manchester Aqueduct Company, which had proposed to supply the city with water provided the city would guarantee the interest on the cost at the rate of six per cent. The city was very willing to guarantee the interest on the bonds, provided the Aqueduct Company would give them all over the six per cent. that they might earn later on, but the project fell through. The surveys were utilized afterwards in the construction of the water works and the development of the water power at Lake Massabesic, and were also used later on by the city when they decided to build the works in 1871.

I entered the service again in 1871, and remained until Mr. Walker's election in 1875. Several schemes were presented, — I think nine in all. Colonel Fanning, whom you all know, was chief engineer, and any project which had any merit was considered. But they gradually narrowed down to two: Pumping by water power from Lake Massabesic, or the conducting of the water by gravity from the head waters of the lake, which, if my recollection serves me, would utilize about one third of the watershed. It has been a question in my mind, looking back, whether we discounted the future enough at that time. Lake Massabesic was then practically an unknown territory. Although it was only four miles from the city it was over a ridge, and the only means of reaching it was by a steam railroad which operated two trains a day. There was a small public house out there, and I suppose if one hundred people went out there in a day in the summer time, it would be something unusual, and, if any thought at all was given to it, it was considered most unlikely that the water would ever become contaminated. But shortly after the works were built the attention of people began to be attracted to the place as a resort, and the result was that numerous houses were built about the lake, and a large summer population came there, which did not conduce to the attractiveness of the lake as a source of water supply, and eventually led to the city taking the matter in hand and buying up the land, so that now, as Mr. Mendell has said, the city owns about 85 per cent. of the lake shore. That has destroyed to a very large extent the taxable value of the property, and in my mind there has been a question whether we didn't make a very serious mistake in the beginning in not taking the supply from the head waters, where it would be delivered by gravity all over the city, instead of putting in a pumping plant which has been enlarged, as Mr. Mendell has told you, several times. I am not prepared to present any exact figures in relation to the matter, but I think that the lost taxes on the property which has been destroyed would have fully offset the larger interest charges of the gravity scheme and left a large asset in the way of a summer resort for the city. The water damages would undoubtedly have been much less, and a very large investment in the pumping plant would have been saved. Of course as it is to-day no one would think of destroying all this property and going back to the original proposition, but it is merely an illustration of how little we know what is going to take place forty or fifty years in the future. I trust that Mr. Mendell will not think I am criticizing him or his associates in any way, but this is the sober second thought after a matter of nearly fifty years.

Mr. Mendell. I might say about two thirds or seven eighths of the property did pay taxes. The back land they are now contemplating using for a park.

Mr. Chase. That will, of course, bring in some salvage.

Mr. Frank L. Fuller. I should like to ask Mr. Mendell whether he doesn't think it would have been of advantage to the city if a filtration plant had been installed and the lake shore allowed to be built up with these small cottages.

Mr. Mendell. That has been considered, and its advantages and disadvantages argued. I think perhaps it might have been if the work had been begun earlier, but the first thought of the water commissioners was to own the land and control it, and they have always acted upon those lines. How much of a development there might have been for a summer colony, if we had had a filter plant, I don't know.

A Member. We would be interested to know what you have done along the lines of your forestry operations.

Mr. Mendell. I presume that most all water works which have a lot of land are doing more or less forestry work. We began forestry work in 1913, and up to the present time we have put out something over 500 000 pine seedlings. This land we have bought is not going to be a total loss to the city, because we have sold, this winter, standing timber which will amount to nearly $20,000, besides probably from 1 400 to 1 500 cords of wood which we have sold on the land at $6 a cord. I presume the city of Manchester could sell to-day $250 000 worth of pine timber on the land that the department owns. This that we have sold is some which is ripe and ready to cut, and we are selling it off in this way.

RICHARD W. BAGNELL.

Charter, Active, and Honorary Member of the New England Water Works Association.

Born December 2, 1822. Died April 1, 1918.

Richard W. Bagnell^3 was born at Plymouth, Mass., on the date named above. He was the son of Richard and Lydia (Sampson) Bagnell, both of Pilgrim and Revolutionary ancestry. His grandfather Richard Bagnell^1, as a soldier, responded to the Lexington alarm in the early days of the Revolution and was a captain in the Continental Army. For three generations, Richard^1, Richard^2, and Richard^3, the Bagnells were expert shipbuilders.

Mr. Bagnell followed his chosen trade until he was over fifty years of age. He was a recognized expert in the technical part of designing the famous clipper ships that placed the American merchant marine in such a commanding position just previous to the Civil War. At this period, Mr. Bagnell worked at East Boston under Donald McKay and other famous designers of the time. During the Civil War, Admiral Farragut was so much impressed with the ability shown by Mr. Bagnell that he endeavored to have him transferred to the famous frigate *Hartford*.

Previous to the Civil War, Mr. Bagnell took deep interest in the state militia and was a member and officer of Plymouth's historic military company, the Standish Guards.

As the maritime industries of Plymouth declined, Mr. Bagnell sought other occupations, and on May, 1874, was elected superintendent of the Plymouth Water Works, a position which he continued to fill until 1901, when Arthur E. Blackmer was elected active superintendent and Mr. Bagnell was retained as superintendent emeritus upon a pension, as a deep appreciation of the good work which he had accomplished. He continued to visit the office daily until a few weeks before his death, and his interest in the details of the work in progress continued to the last.

Mr. Bagnell was married in November, 1848, to Harriet Allen, by whom he had five children; three of them were living at the time of his death.

Mr. Bagnell was one of the three survivors of the twenty-five representatives who met on June 21, 1882, at Young's Hotel, Boston, and organized this Association. He immediately took a deep interest in its affairs, and did what he could to promote its usefulness.

PROCEEDINGS.

MARCH MEETING.

HOTEL BRUNSWICK,
BOSTON, MASS., March 13, 1918.

Carleton E. Davis, President, presiding.

The following members and guests were present:

HONORARY MEMBERS.

E. C. Brooks.
R. C. P. Coggeshall.
Desmond FitzGerald.
Frank E. Hall.
R. J. Thomas. — 5.

MEMBERS.

T. C. Atwood.
J. F. Barrett.
C. H. Bartlett.
A. E. Blackmer.
J. W. Blackmer.
George Bowers.
J. C. Chase.
F. L. Cole.
C. E. Davis.
John Doyle.
J. H. Dillon.
E. D. Eldredge.
Frank Emerson.
F. F. Forbes.
F. L. Fuller.
Patrick Gear.
H. T. Gidley.
F. J. Gifford.
T. C. Gleason.
H. J. Goodale.
A. R. Hathaway.
D. A. Heffernan.
J. L. Howard.
A. C. Howes.
W. F. Howland.
G. A. Johnson.
Willard Kent.
S. E. Killam.
G. A. King.
P. J. Lucey.
F. A. McInnes.
Thomas McKenzie.
H. V. Macksey.
A. E. Martin.
John Mayo.
J. H. Mendell.
F. E. Merrill.
G. F. Merrill.
F. L. Northrop.
W. H. O'Brien.
H. E. Perry.
J. L. Rice.
L. C. Robinson.
P. R. Sanders.
A. L. Sawyer.
Sidney Smith.
G. A. Stowers.
J. F. Sullivan.
W. F. Sullivan.
L. D. Thorpe.
A. H. Tillson.
D. N. Tower.
W. H. Vaughn.
R. S. Weston.
F. I. Winslow.
G. E. Winslow.
I. S. Wood. — 57.

Associates.

Harold L. Bond & Co., F. M. Bates and F. W. Mattheis.
Builders Iron Foundry, A. B. Coulters.
A. M. Byers Co., H. F. Fiske.
Carbic Mfg. Co., E. G. Frey.
Chapman Valve Mfg. Co., V. N. Bengle and C. E. Pratt.
Edson Mfg. Co., H. L. B. Watson.
Hersey Mfg. Co., W. A. Hersey and J. H. Smith.
H. Mueller Mfg. Co., Chas. J. G. Haas.
National Meter Co., H. L. Weston.
National Tube Co., H. T. Miller.
National Water Main Cleaning Co., B. B. Hodgman.
Pittsburgh Meter Co., J. W. Turner.
Rensselaer Valve Co., C. L. Brown, I. A. Rowe.
George H. Sampson Co., W. T. Page.
Thomson Meter Co., E. M. Shedd.
Union Water Meter Co., H. W. Jacobs, E. K. Otis.
Warren Foundry & Machine Co., W. F. Woodburn.
Water Works Equipment Co., W. H. Van Winkle.
R. D. Wood & Co., Charles R. Wood.
Worthington Pump & Machinery Corp., W. F. Bird, Samuel Harrison, E. P. Howard. — 27.

Guests.

Massachusetts.

Boston, G. A. Caldwell, F. W. Sears.
Haverhill, Frank G. Hamlin.
Onset, Silas L. Briggs.
Springfield, J. J. Fitzgerald. — 5.

Mr. Desmond FitzGerald, consulting engineer, Brookline, Mass., entertained the members with a talk on mountain scenery, beautifully illustrated with colored slides. Mr. James H. Mendell, superintendent of water works, Manchester, N. H., read a paper entitled, " The Past and Present Pumping Equipment of the Manchester Pumping Stations." Mr. R. C. P. Coggeshall, superintendent of water works, New Bedford, Mass., gave a brief description of an electrically driven unit recently installed at New Bedford. Mr. John C. Chase spoke of the early history of the Manchester, N. H., water works, with which he was connected in the early seventies.

Mr. Albert L. Sawyer, water registrar, Haverhill, Mass., read a paper entitled, " Recent Legislation and Decisions of the Courts with Reference to the Sanitary Protection of Water Supplies." The general subject was discussed by Mr. Percy R. Sanders, Mr. James H. Mendell, and Mr. Patrick Gear.

The President called upon Mr. McInnes for a report of progress from the Committee on Revision of Standard Specifications for Cast-Iron Pipe and Special Castings.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE AND SPECIAL CASTINGS.

MR. FRANK A. McINNES. My report is only in the line of informing the members in regard to the answers to the questionnaire which we sent out about two weeks ago. We have received several replies from the west coast, but I am sorry to say that comparatively few have been received from this neighborhood. Thus far, 88 replies in all have been received.

The first question on the questionnaire was, " Do you think a revision of the existing specifications desirable? " To this the answer has been " Yes " in 69 cases and " No " in 11 cases; that is, 86 per cent. of those who have answered have said " Yes."

To the second question: " Are you in favor of the adoption of uniform outside diameter? " 67 replies are " Yes " and 16 " No "; that is, 80.7 per cent. are " Yes."

To the third question: " Are you in favor of specifying chemical requirements of the metal? " The replies were 62 " Yes " and 17 " No "; that is, 78½ per cent. " Yes."

To the fourth question: " Are you in favor of a relation between flexure and breaking load? " 55 replies were " Yes " and 14 " No "; that is, 80 per cent. " Yes."

That is all I have to say, gentlemen. We were anxious to find out what the opinions of the members were, and so far as the replies have been received it looks as though there was to be more work for the committee to do.

THE PRESIDENT. Your thought is that the committee will receive more answers to the questions you have sent out?

MR. McINNES. Yes, I think there is no reason why the proportion of favorable answers should not continue.

THE PRESIDENT. I think there is no doubt that the American Water Works Association will also send out a similar questionnaire after their May convention in St. Louis.

Mr. Patrick Gear. We have about a thousand members, and according to the report which Mr. McInnes has given, showing that there have been 88 answers, I should say they would represent perhaps more than 50 per cent. of the membership. I answered for Holyoke and there are six members of the Association from Holyoke, and my answer is for the water department.

The President. It seems to me that the time has been rather short, and doubtless there will be more replies.

Mr. McInnes. I think that is true, but I thought it would perhaps be interesting to the members to know what progress was being made, and it might stimulate other answers.

Mr. George F. Merrill. In connection with the specifications for cast-iron pipe, the thought occurred to me that possibly it would be wise to include some standard specifications for branch pipe, particularly for branch specials, elbows, and branches, which are made of different radius and length and different distances from center to center, for if any one has to deal with that class of work it is difficult to get competitive figures on the same details. Furthermore, many fittings of that kind are used around the pumps, and in case of a breakage it is difficult to obtain one on short notice. If these were standardized more, it seems as though it would be easier to obtain fittings that fit.

Mr. Henry A. Symonds. I think that, after considering the discussion at the last meeting relative to what should be the answers to these questions that our committee has sent out, we are more than ever impressed with the lack of knowledge of what are the real objections to carrying out the suggested changes. The manufacturers have taken an attitude that plainly implies that there are serious objections. This is a matter that has already been threshed out to a certain extent before the Association, but in reviewing the matter it was impressed upon my mind very forcibly that we have been practically told that, if the Association is to go ahead through its committee and revise the specifications as suggested, the consequences might be serious.

Now, in the face of statements of that kind I am at a loss to understand why the manufacturers will not come out frankly and tell us what they mean. There can be no question about the desirability of having uniform outside diameters and all the improvements which have been suggested in the changes in the specifications, if there are no serious objections. Now, are they going to be purchased at a great expense, or what does it mean? Can't we get some frank answer from the manufacturers to enable us to consider their interests and our own interests as users of cast-iron pipe, and see both sides of the question?

Mr. McInnes. I should like to say a word or two. Since this matter has been re-agitated within the last month or two months I have had representations from three, at least, of the most prominent manufacturers of pipe in the country, showing me — I don't know just how to express it — that there has been an unfortunate misunderstanding. I am very sure that there is no disposition or wish or desire on the part of the pipe manufacturers to do anything other than to give us full information. I am personally satisfied of that fact. Unfortunately there has been some misunderstanding, but I think we will have no difficulty in getting all the information we want.

The President. I am glad the point has been brought up in the way it has been by Mr. Symonds, and I am glad to hear what Mr. McInnes has said in reply to it. It seems to me that if the manufacturers are not ready to state their position just now we might very well say that we will devote a portion of the next meeting to clearing up any misunderstanding there has been in the past, and that the manufacturers be asked to state at that time their position, if they feel that they haven't already made it clear, or if members of the Association feel that they have not succeeded in making their position clear. We should be glad to hear any representatives of the manufacturers to-day if they care to be heard, but if not to-day they can be ready at the next meeting to state their side of the case. The Secretary reminds me that there is no meeting between now and the fall convention, except the June meeting, which is usually more of a special meeting, so that possibly it would be well to hear from the manufacturers to-day. I will ask Mr. Wood if he has anything to say.

Mr. Wood. I don't think the manufacturers will have any objection to giving their reasons for objecting to certain things in the specifications; but, speaking for ourselves, we haven't anybody now who has time to go into it. That is a remark I made at the meeting of the American Association and I was pretty sharply criticized for it, but I can't help making it. We have about twenty-five per cent. of the men we ought to have in our engineering department and drawing room, and I think most of the iron-pipe manufacturers are in the same condition. These things will have to be gone over very carefully, and I will say for ourselves that I think we can get something to submit to the committee regarding our own ideas on the subject between now and the time of the annual convention. But it is something that we have got to go over very carefully and fully, and it isn't anything that we can give an opinion on right off-hand. I don't mean to say that we haven't already had a lot of time, but we have had many other things to do.

THE PRESIDENT. What would you think of having a part of the time at the annual convention given up to this subject? Of course at that time we would have the benefit of any decision reached by the American Water Works Association.

MR. MCINNES. And I think it is possible that by that time the committee may have made some progress.

THE PRESIDENT. Then we will leave it in this way, with the hope that the committee and the manufacturers together may be able to make considerable progress between now and next September.

Mr. D. A. Heffernan, superintendent of the Milton water works, Milton, Mass., read a paper giving an account of his experiences in thawing out frozen services during the past winter. Mr. Patrick Gear, Mr. Wright, Mr. Frank A. McInnes, Mr. F. F. Forbes, Mr. Henry A. Symonds, Mr. R. C. P. Coggeshall, Mr. Frank L. Fuller, and Mr. A. E. Martin participated in the discussion, which culminated in the adoption of a motion made by Mr. McInnes that a committee be appointed to report, not later than at the annual convention, on the general subject of thawing frozen water pipes and collateral matters. The President said he would announce the members of the committee later.

Adjourned.

EXECUTIVE COMMITTEE.

Minutes of meeting of Executive Committee of The New England Water Works Association held at the rooms of the Association, Tremont Temple, Boston, Mass., March 13, 1918, at eleven o'clock A.M.

Present: President Carleton E. Davis and members Samuel E. Killam, Henry V. Macksey, Thomas McKenzie, Frank J. Gifford, A. R. Hathaway, and Willard Kent.

Messrs. Charles W. Sherman, Samuel E. Killam, and Frank J. Gifford were made a Committee of Arrangements for the June Outing.

A communication from the American Numismatic Society, of New York City, requesting a copy of the Brackett Memorial Medal, was presented and the subject was referred to Mr. Charles W. Sherman with the recommendation that the request be granted.

A copy of Digest of the electrolysis publication of the Bureau of Standards, compiled by Samuel S. Wyer, consulting engineer of Columbus, Ohio, was presented and recommended to the attention of the members at the meeting of the Association this day.

Discussion on the place of holding the next annual convention was held; final decision was deferred until further information could be obtained.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

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OF THE

New England Water Works Association.

1918.

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George A. Carpenter, City Engineer, Pawtucket, R. I.
Edwin L. Pride, Public Accountant, Boston, Mass.
Bertram Brewer, Supt. of Sewers and Water Works, Waltham, Mass.

THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of about 1 000 men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are FOUR dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues TWENTY dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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New England Water Works Association.

ORGANIZED 1882.

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This Association, as a body, is not responsible for the statements or opinions of any of its members.

FROM PEACE TO WAR, FROM WAR TO VICTORY, FROM VICTORY TO JUST JUDGMENT.

BY PROF. WILLIAM T. SEDGWICK.*

[Delivered September 11, 1918.]

Mr. President and Fellow-Members, — When I learned that we were to have a September meeting as usual, and one with a war program, I asked the privilege of coming in and saying a few words — and I will promise not to say many — about the general situation, for it seemed to me that we ought not even to get together without reviewing briefly war conditions and the war outlook. Here we are, plunged into the worst war that the world has ever known, and instead of meeting in our usual peaceful fashion and talking about pipes and piping, about reservoirs and dams, and about water and its quality, we find ourselves discussing shortage of fuel, the building of huge army supply depots and enormous destroyer plants, and asking how long this condition is going to last and what it is all about anyhow. For when we look back a little we remember that only a few years ago we were moving along in a peaceful, happy, contented and prosperous fashion, grumbling of course about many things, — that being the privilege of mankind, — but as we now look back, mostly contented and happy, with the world advancing as we believed toward improved and better conditions; when, all of a sudden, we woke up to find that we were in the very midst of something we had read about, heard about, dreamed about, but hadn't believed could ever again possibly be.

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*Past President, New England Water Works Association; chairman, Massachusetts Division, National Security League.

I, for example, had gone to Europe in 1914, as I was fond of doing, in that summer vacation which was one of the rewards of the teacher; and my wife and I were in the Pyrenees, that most beautiful mountain range between France and Spain, up in the mountains, not far from Lourdes about which you have all heard, when we picked up the paper one day and found that the Crown Prince Ferdinand of Austria had been assassinated in Serajevo, the capital of Bosnia. It so happened we had been watching Bosnia and the Balkans, for only a few years before we had been in Serajevo and knew the city and had made quite a little study of the Balkan problem, the near East, and all that; so that when, on the 28th of June, we read that the Crown Prince of Austria, the nephew of the old emperor, had been assassinated, we knew that there must be something underneath it. What it was we didn't know; but we did know that Ferdinand was very unpopular with the Austrian nobility, and that he was not at all a favorite with the old emperor whom he was to succeed. We knew that he had been hobnobbing with Emperor William, and as we had known all about Emperor William's intrigues in Turkey and the Balkans for some time, and had been very suspicious of them, we feared that something was brewing which was not for the good of the world. But we didn't know what it was, or how far it would go. So we went on to Paris, and one day in Paris, about a month later, on the 23d of July, we took up a paper and found that Austria had sent to Serbia a vicious ultimatum which could only mean war. This practically accused Serbia, a little country compared with great Austria, of causing the murder of the crown prince, who happened to have been in Bosnia near Serbia and to have been murdered by a Serbian subject. The ultimatum went on to say that Serbia must do this and do that and do the other, and said it in the most peremptory language; so that I at once exclaimed, "This must mean war, because no self-respecting nation can swallow terms like those and live. Her people would upset the government." And then, two days later, as we crossed the Channel, for they only gave them forty-eight hours in which to decide, to our very great surprise we found that Serbia had eaten dirt, that she had swallowed all of those peremptory demands except one or two, and had promised to consider even those very carefully if she could have a little more time. That meant, of course, that Russia had said to her, "Don't resist, because if you do it will bring on a European war, and we will see you through this thing somehow or other." But it was already perfectly evident that Austria wanted war, and we now know that Germany wanted it and was behind Austria. And, sure enough, three days later war was declared by Austria on Serbia, and within a week the whole thing was going.

Up to this time we had had peace, and then all of a sudden we were plunged into war. I say "we"; and I mean the world. At that time you and I stood off and said, "Well, we don't understand this thing; it is a long way off and we guess it doesn't amount to anything. Probably it is a small affair." And even Great Britain tried to look at it in that way at first. But France knew that it probably meant invasion, and Russia knew it; and, as we now know, the facts were these: On July 5, between the time of the death of the Crown Prince Ferdinand and the ultimatum to Serbia, — and we have the word of our ambassador to Turkey for this, Mr. Morgenthau of New York, — on July 5, Emperor William called together the great men of the German Empire and said, "Are you ready?" And most of them said they were. The Army? Yes. The Navy? Yes. Everybody but the bankers were ready. The bankers said, "We are not quite ready. We want two or three weeks more in order to unload our American securities and gather a little more gold, and then we will be ready." So with that understanding the emperor goes off on a pleasure trip, an alleged pleasure trip, just as a blind, but he doesn't get out of close touch with his people. Mind you, this was on July 5, and on July 23 the ultimatum was sent to Serbia — a little more than two weeks afterwards, the two weeks which the bankers required. And if you will study the reports of the bourses and stock exchanges you will find that during that time there was a very remarkable slump in the stock markets of the world. Nobody then understood just what was going on, or why stocks were being unloaded. But we now know the reason, which was that

German bankers were unloading and getting ready for the 23d of July, when the ultimatum was to be sent by Austria to Serbia. And that is the way we were plunged from peace into hideous, needless war. For it was evidently the design, the malevolent design, of Germany and of Austria, Germany's vassal and tool, to launch a war for domination of the world; and when the day had come, as they decided on July 5 that it had come, it simply had to be. Nobody asks, to-day, who began the war. But why did Germany choose that particular time? We know now. She had been informed by her ambassador in London that the Irish problem was so acute that Great Britain would never think of going into a continental war; that the suffragettes were making so much trouble that Great Britain had all she could attend to at home with them and the Irish question. And I, myself, in Paris, read how in the French Chamber of Deputies it was said, "Our cannon are not right; they are not what they ought to be; we are not prepared for war." They really overstated it, for they were better prepared than they realized, but that statement was unquestionably caught up by the German spies in France and reported at home. And the Germans said, "Great Britain is occupied with Ireland and the suffragettes, and the French cannon are not what they ought to be; and Russia, as everybody knows, has not yet fully recovered from the Japanese war. Now is the time for us to beat the world. Turkey is practically on our side, Austria is always with us, and now is the time for us to do it and do it easily."

We know now all about the beginnings of the war, or at least we know enough so that we have no doubt whatever as to who started it, in spite of all the lies which emanate from Germany about Russia having started it and Great Britain having started it, and no doubt by this time they are saying that America started it. It is easy to say these things, and to say "*Gott strafe England*," "*Gott strafe America*," *Gott strafe* anybody who happens to come along and to get in Germany's way, but the facts are gradually coming out and coming into good shape, so that we know what the truth is. Everybody now knows that for forty years Germany had been planning something of this kind and accumulating vast stores of ammunition and supplies. And why? Was it because she was poor or oppressed and had to defend herself? By no means. She says she wanted the freedom of the seas, but her ships were on every sea and in every port, and her commerce was flourishing. The words " Made in Germany " were seen on manufactured articles on every hand. Why, then, did Germany begin the war? She began it simply, I believe, because of her easy success in 1870. In 1870 Germany swept through France, captured Paris and wrung from the French people an immense " indemnity " — for what? — for having wronged them. And all these later " indemnities " which she has imposed on Belgium and Serbia and other countries or cities, these are " indemnities " for what? They are indemnities for suffering at the hands of Germany. It is as if a footpad should hold you up on the street, take away your valuables and kick you into the gutter and then say, " Now, my friend, you have got to pay me an indemnity for all this."

We don't like that kind of thing in this country, and we don't think that the world at large likes it, and I don't think it is going to work in the long run. But Germany, finding it an easy matter in 1870 to get from France the money which has since made her rich by enabling her to become a great industrial and manufacturing nation, — for up to 1870 she was largely an agricultural nation and forty years after had become a great manufacturing and commercial nation,— finding, as I say, in 1870, that it was " easy money," that piracy and burglary paid, decided to do it over again, only this time she would try it on the whole world. There is no record in all history, so far as I know, where a prosperous, successful, and happy nation has been so greedy, so full of burglary and piracy and crime and eagerness to rob and plunder her peaceful neighbors. It is unique, except for the Roman Empire, and I believe that in this thing the German nation is emulating the Roman Empire of ancient and unsavory memory.

So Great Britain, France, Belgium, and all the rest were forced into war for self-defense, and we finally joined them, as we ought to have done before we did. And you know what is going on today. You know how over there, on the fair fields of France, our young men are bleeding, not only for you and for me, but for our ideals, for our liberty, for our right to the peaceful pursuit of life and happiness, and for all the things that you and I most value. And we who are here, — and I have been surprised to see, this afternoon, though I need not have been surprised, how the gray heads predominate over the others — we old men who are left while the young men are on the fields of battle, should not leave a gathering like this without the high resolve that we will do what we can here at home to back these fine young fellows who are giving their lives, and many of them their all, for the benefit of all of us, for you and for me and for civilization and for everything that we have and are and would be. And now through all this struggle there is but one thing that we can stand for, and that is for *victory*. We drifted from peace to war, we are now laboring from war to victory. It is true that we have made magnificent progress. It is true that the German salients are being straightened out, but we are still a long, long way from victory, and nothing less than a pushing on and over the frontier will satisfy us or will bring permanent peace to the world. That day will not come probably this year, — it may, — by good fortune it may, — but General March, our chief of staff, and others who know or ought to know, put it next year, — when the destroyers about which we have heard this afternoon have protected our troop-ships so that millions more than the 1 600 000 who have now embarked shall have gone over to the other side and have taken their places in the battle for liberty and civilization; — when all this has happened, then the gradually exhausted German armies will be driven back over the Rhine upon their own soil and made, I hope, to taste some of those same bitter horrors of war that Germany has imposed upon other nations. And I say this not with any desire for revenge or for cruel reprisal, but simply as a matter of preventive medicine. Germany has got to take her medicine. She has got to learn that this kind of burglary, this kind of buccaneering, does not pay. In 1870 it did seem to pay, although I doubt whether, all things considered, it did pay. If it brought on this war, if it led to this wrongdoing, if it leads, as I believe it will lead, to the downfall of Germany, — then surely it did not pay. But whether it appeared to pay or not, Germany has got to be taught at this time and for all time that such things do not pay; that there is no money and no glory in them, but that even for her they mean only blood and tears. Not for revenge, not for mere punishment, but that for all time to come the world may be more peaceful, that this kind of embarkation upon world domination may cease; that hereafter a nation may expand through the legitimate channels of trade and influence by even-handed and fair competition, but not with cannon, not with murder, not with submarines to blow to pieces the merchant ships of neutrals. Where is international law to-day? Germany has violated all codes of honor and all international law. She has made herself the great criminal of the age, and she has got to learn that that sort of thing does not pay. For precisely as you lock up a marauder, and precisely as you electrocute a murderer, not for revenge, but to make stealing and murdering unpopular, the German nation must be so punished that she will never again embark on a plundering expedition of this kind, and that other nations, seeing her downfall and punishment, shall be warned against similar excursions. [*Applause.*] Let us turn aside from all who would urge peace by compromise. Let us have no peace negotiated around a table. Let us have first *unconditional surrender* [*loud applause*], and after that *justice* and *judgment.*

Our Massachusetts senior senator, Mr. Lodge, has put it splendidly in a great speech, and while the details of his requirements for peace will doubtless be varied by those who have to do with them, his general principles are perfect. " Belgium must be restored. Alsace-Lorraine must be returned to France, — unconditionally returned, — not merely because sentiment and eternal justice demand it, but because the iron and coal of Lorraine must be forever taken from Germany. *Italia irredenta* — all those areas where the Italian race is predominant, including Trieste, in Austria, must go back to Italy; Serbia and Roumania must be established in their independence and Greece must be secure. Most important of all, if we are to make the world safe in the way we mean it to be safe, the great Slav populations now under the government of Austria — the Jugo-Slavs and the Czecho-Slovaks, who have been used to aid the Germans, whom they loathe — must be established as independent states. The Polish people must have an independent Poland." And so on. I will not stop to read it all, but if any of you want to get the speech drop Senator Lodge a line and he will send you a copy. I wish you all might read it, because you have in it the whole story from the lips of one of our leading statesmen, a man who, I believe, has great knowledge and great wisdom.

So, then, after victory comes judgment, based upon justice, but seeking the security of the world. Justice and mercy are not the same, and yet perhaps they may be the same; and so you must harden your hearts for the sake of justice and real mercy and must make murder and piracy unpopular for all time to come by carrying this thing through to the bitter end. And it is going to be very real, my friends. The Germans are not going to keep retreating steadily. They are going to *stand*, by and by. But I do believe that, just as surely as the sun rises in the morning, civilization and all who love civilization are bound to triumph in the long run. But it will be a long, long trail, — a long, long, bitter way.

The great danger to-day is that we shall be too good-natured; that we shall say, " Well, after all, isn't it better to stop now and settle it up by a little concession from what would be the right thing? " We must steel our hearts, we must steel our actions against that sort of thing. Justice is a hard word. Justice is the termination, the end of struggle. You and I who deal with groups of men, if we take the right attitude in this matter, may have great influence; so I asked the privilege of coming here this afternoon to say these few words, believing that these words, and others like them, might reach large audiences all through New England.

We are very proud of our Association; we are proud of its past. I, personally, am exceedingly proud of my membership in it and of that high office to which you called me some years ago. I look back upon that with great pleasure. I want to see this Association more than a routine body which goes around like a squirrel in a cage. Each one of its members should stand out in his community for justice and for peace only after unconditional surrender upon the soil of Germany, not outside of Germany, so that she may feel some of those same horrors she has inflicted on other people. Then, I believe, a peaceful era will dawn upon the earth, for it will then have been demonstrated that piracy does not pay, that the breaking of international law, the wanton burning of peaceful villages, the plundering of men and women and children, and things that we have been used to associate with savagery and barbarism, do not pay; that in the long run comfort and well-being and prosperity and happiness go with the Christian virtues of mercy and justice and pity, upon which the Kaiser and his minions have turned their backs. He is forever prating about God, "*Gott mit uns!*" — their God, the German God. Does he ever mention Christ and the Christian spirit of peace, of love, of mercy, of self-abnegation, self-denial, and all that? Never. It is always the ancient God, the God of battles, the God of hosts. But, my friends, we have got beyond that. We have an ideal to-day which is higher than that, — the ideal of Christianity as well as the ideal of civilization. [*Prolonged applause.*]

THE PRESIDENT. This is a very inspiring conclusion of what has been a very successful session of this war-time meeting of the New England Water Works Association. Professor Sedgwick's outline of the causes that led up to the war and the incidents surrounding the start of the war in the month of July has been very illuminating. I think we can feel the same way about his prediction of victory and judgment to come, — that it is just as well founded as his outline of how the war started. Professor Sedgwick referred to the number of gray heads here this afternoon. There was a time when he was twice as old as I, but the proportion is rapidly decreasing. I used to have a feeling of considerable awe in the presence of Professor Sedgwick; perhaps I may stand in somewhat less awe of him now, but I have no less respect and admiration. [*Applause.*]

MR. CALEB M. SAVILLE. I think the Association owes another debt to Professor Sedgwick, and I think it should give him a vote of thanks for the address he has made to us this afternoon and the thoughts he has left with us. I would make that as a motion.

The motion was adopted by a rising vote, amid great applause.

SAVING OF WATER AND CONSERVATION OF COAL.

BY GEORGE A. CARPENTER.*

[*September 11, 1918.*]

When the writer was notified that the President had appointed him a committee of one to "investigate statistically the relation between the saving of water and the conservation of coal," he began to wonder just what kind of a proposition he was up against.

From his personal experience he was inclined to believe that statistics, as ordinarily compiled, might be used to prove most anything, and was strongly tempted to write and ask the President which side of the proposition he was committed to and wished substantiated.

However, rush of work, lack of assistants in the office, the vacation season, and many other seemingly *legitimate* excuses, all of which might be summed up in one word, procrastination, finally forced the writer to go ahead without compelling the President to disclose his position.

It was quite natural that the writer's first thought should turn to the "Summary of Statistics" adopted in 1902 by this Association for the use of its membership, and he wrote at once to the Secretary asking where these data were filed. Judge of his disappointment when told that this fruitful source of information, provided for just such emergencies as the President sought to meet, had failed to materialize, that only a few were using this form of return, and that very little data of the kind desired were in the files of the Association.

Time was short, there was but one thing for the writer to do and that was to avail himself of statistics compiled by others. He has previously intimated, however, that he has no unshaken belief in the infallibility of statistics as generally compiled. He has been the subject of too many interviews with agents of statisticians, who have generally insisted upon answers to *all* questions propounded on the blank form expected to be filled in, regardless of the fact that records were not kept in a way that would furnish these data. And when the interviewed expressed his inability to furnish the information desired the interviewer himself has filled the blank by a guess rather than turn the sheet in with some questions unanswered.

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* Superintendent of Water Works, Pawtucket, R. I.

Statistics carefully compiled, by one who appreciates what the figures represent, knows how they were obtained and can properly weigh and state their values, may be of great assistance, but figures compiled by one who takes no consideration of how or by whom they were recorded, or what they mean, may be very misleading.

However, in the very general way in which the writer proposes to treat his subject, perhaps figures taken from a report of the Census Bureau may furnish ideas, give food for thought, and lead to a more careful study of the question. At any rate, these were the only figures available in the limited time at the writer's disposal, and he has used them to ascertain where they will lead.

The Report of the United States Census Bureau for 1915 gives statistics of 155 cities which own their own water works. These cities had a total population, in 1915, of a little over 26 millions, and are reported as pumping an average of 3 748 million gallons of water per day, 80 per cent. of which is pumped by steam power.

On the above basis the average, daily, per capita consumption of water pumped by steam is about 114 gal., and for every gallon per capita saved daily there may be expected a daily saving of approximately 14½ tons of coal.

The above figures of coal saved are obtained in the following manner:

The report referred to states that 80 per cent. of the water supplied is pumped, and that 80 per cent. of the pumping is done by steam power. This indicates that 64 per cent. of the total water supplied is pumped by steam power. The report also states that the average horse-power of the pumps, per million gallons capacity, is 36.

Assuming a saving of 64 per cent. of 26 million gallons daily, an average of 36 h.p. per million gallons, equivalent to a head of 207 ft., and a coal consumption of 2 lb. per horse-power-hour, we obtain the 14½ tons used above.

A daily saving of 14¼ tons of coal means an annual saving of approximately 5 200 tons, produced by reducing the per capita consumption throughout the country 1 gal. per day, and 52 000 tons per year by a per capita reduction of 10 gal. per day.

Can water consumption throughout the country be reduced 10 gal. per capita per day? Yes, that amount and more too, on the average.

The writer, however, does not believe that this saving should be made by a *uniform reduction* of all consumption, regardless of present rates, for there are many cities that have already reduced water consumption to a very low figure, while others are wasting water in a prodigal manner.

An examination of the tabulated statistics of 148 of the cities reported, representing a total population of 25 644 000, indicates a daily per capita consumption varying from a minimum of 34 gal. per day, for the city of Woonsocket, to a maximum of 324 gal. per day for Buffalo, N. Y.

In 1894, Dexter Brackett, a past president of this Association, made a critical study of the future per capita consumption of the city of Boston for thirty years, and placed the figure at 100 gal. per day.

The latest report of the Metropolitan Water and Sewerage Board shows that the per capita water consumption of Boston and the Metropolitan District rose from about 90 gal. per day in 1894 to nearly 130 gal. per day in 1907, but, with the compulsory use of meters after January 1, 1908, the consumption dropped rapidly to an average of 90 gal. per day in 1917.

Messrs. Hering, Wilson, and Gray based their estimates for water for Philadelphia upon a daily requirement of 150 gal. per capita.

Messrs. Hill, Benzenberg, and Whinery based estimates for Cincinnati on 130 gal. per capita, and Mr. John R. Freeman used 125 gal. per capita per day for New York in 1905, with a legitimate increase of one gallon per day to a per capita consumption of 150 gal. per day in 1930, stating, however, that these figures were made on the basis of " the greatest effort to restrict waste that public sentiment will probably demand or support."

In the report of Committee on Water Consumption Statistics and Records, made to this Association in 1913, the average daily consumption for 113 cities of the United States is given as 121 gal. per capita; England, 38; France, 54; and Germany, 28.

The average daily per capita consumption for the 30 New England cities listed in the report previously referred to is 82+ gal.

Of the 150 listed in this Census Report of 1915, 55, representing a total population of 4 590 000, now have an average per capita consumption of less than 100 gal. per day; and 88 cities, with a population of 14 546 000, have an average of 125 gal. or less per day.

If we assume that 125 gal. per capita daily is a reasonable allowance, we find that 48 cities could save a total pumpage of 663 million gallons daily, and that of this total Chicago alone could save 37 per cent. by reducing its present consumption of 226 gal. per capita per day to 125 gal. The four cities of Chicago, Philadelphia, Pittsburgh, and Buffalo, with respective averages of 226, 182, 252, and 324 gal. per capita, could save 495 million gallons per day, or nearly 75 per cent. of the total.

If we make the same assumption with respect to the 663 million gallons that could be saved by the 48 cities referred to, — namely, that 80 per cent. of the pumping is by steam power, — we have a total of 530 million gallons pumped by steam; and by applying our previous assumption as to the use of coal to pump this amount of water, we have a possible saving of 458 tons of coal per day, or 32 times as much coal as could be saved if *all cities* reduced the per capita consumption by one gallon per day.

Four hundred and fifty-eight tons daily is about 167 000 tons annually, and Chicago, Philadelphia, Pittsburgh, and Buffalo could save about three quarters of this, or 125 000 tons, by a reduction of the average per capita water consumption to a figure already reached or improved upon by 88 cities out of the 148 cities reported.

If we assume a per capita allowance of only 100 gal. daily, a very much greater saving of coal can be made.

The writer believes, however, that a reduction of consumption to reasonable limits is not the only objective which should be sought in order to obtain a conservation of fuel. Pump slip is often a source of an enormous waste of power. We often find reports where total consumption, engine duty, etc., are figured to all manner of degrees of precision, only to discover upon critical inspection that all these figures are based upon plunger displacement, with no knowledge of, or attention paid to, the probable slip.

Referring to the figures previously used, 3 748 million gallons pumped daily by 155 cities in this country, and calling 80 per cent. of this pumped by steam, we obtain 3 000 million gallons. If we assume a slip of 5 per cent. only, use our previous figures of 36 h.p. per million gallons, and 2 lb. of coal per horse-power-hour, we find that this slip is equivalent to the wasting of 130 tons of coal per day, or nearly 50 000 tons per year. This is about as much fuel as we found would be saved by reducing the average per capita consumption of the 155 cities previously cited by 10 gal. per day.

And if we stop to consider that in many pumping plants the reducible slip is probably greatly in excess of 5 per cent., we may realize that one profitable field of investigation may lie very close to the pumping station itself.

To assume, however, that a conservation of fuel can be obtained by a *uniform reduction* of the per capita consumption of water throughout the United States, without first giving wide publicity to the wastefulness existing in certain cities, is unfair to those cities and officials now using every effort to keep water consumption within reasonable and proper limits and conserve and increase pump efficiency. It will furnish one more example of the faithful, conscientious citizen, hastening to do his bit and carrying also the additional burden caused by the thoughtless extravagance and wastefulness of those who will not or do not care.

Never before in the history of the world has the absolute dependence of one nation upon another, one community upon another community, and one individual upon another individual, been recognized to the extent that it is to-day. This world-war has brought home to thinking minds a realization of individual responsibility, of the necessity of unity of purpose and of individual sacrifice for the common good, that could have been produced in no other way.

To-day, therefore, is an opportune time to bring to the attention of those cities, where prodigal use of water amounts almost to a crime, the fact that such wastefulness is far-reaching, that its effect extends beyond the borders of the city itself and may reach even across the seas, tending to withhold from those brave men upon whom civilization now depends for its existence, the arms, ammunition, and supplies needed in its defense.

PRACTICAL METHODS FOR DETECTING LEAKS IN UNDERGROUND PIPES.

BY DAVID A. HEFFERNAN.*

[*September 12, 1918.*]

The unparalleled severity of the past winter, with all its attending evils, seemed especially applied toward water works, and makes timely a discourse on this subject. There is no question but that, in the memory of any of us here present, the past winter has never been surpassed in its destructive aggressiveness, at least, since water-works systems became a fact and not a theory.

The unprecedented depth which the frost reached was the cause of more leaks in two months than the average superintendent would have to combat in a year. The ravages of the cold touched with ill effect most every sort of installation or appliance used in connection with the business, affecting the ball-cock in the tank in the private home on one extreme and the hydrant in the street on the other. It may, therefore, be safely said that, in addition to showing an extraordinary jump in cost of maintenance, water-works reports for 1918 will also show a large increase in the number of leaks. Even though the cold spell ended five months ago, all its effects have not yet been felt. So that while this little paper is not intended as an authoritative essay it may be that a few helpful hints will be gleaned from it.

It is estimated that the daily per capita consumption of the Metropolitan Water Distribution System, as included in Boston and vicinity, is about 16 per cent. higher than last year. A part of this may be accounted for in the increased use due to work pertinent to the war, as especially applied to Quincy and Watertown. But the remainder must be held to be an after result of the winter.

In February, the average increase for the district was 29 per cent., in four different cities and towns reaching 135 per cent.,

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*Superintendent, Water Works, Milton, Mass.

129 per cent., 125 per cent., and 104 per cent. Of course, this was due to running water from inside taps to prevent the possibility of services freezing, and should not be considered as waste water in its narrower sense as applied to leaks. The present high consumption, though a result of the winter, is waste, pure and simple. It is a matter of patriotism for every superintendent to use every means at his disposal to combat the wasteful and needless use of water.

It has been calculated that if the waste water be eliminated from our systems, 150 000 tons of coal would be saved yearly in New England alone. And it must, by this time, have become apparent to us all that if New England does not extricate herself from the position in which she was found last winter the Fuel Administration will not. So it simply devolves upon us here to help in its accomplishment. The efforts of the superintendent should be largely centered on the endeavor to better his system by minor improvements. The war has restricted building, and in some places completely abolished it. As the necessity for the extension of mains is entirely dependent on new building operations, if building has stopped, the money and labor hitherto used in construction can be better applied in the improvement of the system; and there is no water-works plant so near perfection that extensive improvements cannot be made. One of the most satisfactory ways of employing this energy is by reducing the waste of water. The responsibility for this waste water lies in two places, with the consumer and distributor. The distributor has or should have the knowledge of how to correct the evil, and also the ability to impart this knowledge to the consumer. To educate the consumer to the point where he realizes that it is for his own benefit to stop the use of water beyond the amount actually consumed for useful purposes should be the duty of the distributor. I think all are familiar with the recognized methods. Press articles bring good results, and mailed or distributed circulars, with plate showing various-sized openings, with the amount of water each would permit the escape of and the cost of these amounts of water in tables, are satisfactory agents.

In conjunction with a campaign of this sort, it is well to have inspectors make a house-to-house canvass, looking for defective plumbing. It should be explained to consumers receiving water by meter that it is much cheaper to pay plumber's bills than to pay for water from which he has received no benefit. In the case of a flat-rate service, the threat of cutting off his supply, if repairs are not made, is effective. The inspector should be equipped with an aquaphone, and, as he visits each house, should listen on the pipe in the cellar for a leak on the service. In this manner, a quantity of small leaks will be discovered and repaired.

The distribution system presents a different problem. The simplest method of detecting leaks is by means of daily consumption comparisons. This presupposes the fact that there is some means of measuring the amount of water supplied to the distributing mains. This measurement may be made by computing the flow over a weir, by piston displacement of pumping engines, or by the actual measurement by Venturi or other meter. If by the second method, careful allowance should be made for slippage.

In the consumption book, daily records should be kept of the amount supplied to the mains. With this should be kept the relative conditions that might cause a variance in consumption, such as conditions of weather, fires and their duration, blowing-off operations, and leaks discovered. With these facts at hand, it is possible to estimate fairly accurately the cause of any sudden increase in consumption. For instance, Monday usage, as a general thing, will be larger than any other day of the week because it is the customary wash day. A day on which a large fire occurs will show an increase. Opening a number of hydrants on dead ends for the purpose of clearing the mains will show an excess, as will a prolonged spell of dry, hot weather. So that, if a sudden increase in the use of water occurs with none of these factors entering, it is a safe wager that a leak or leaks exist in the system. If the measuring device has a self-registering attachment, to watch the night-flow (between 1 and 4 A.M.), it will give indications of the condition of the system.

After the fact of the presence of a leak has been established, it is next in order to find it and make the necessary repairs. There are several methods for its discovery. The old-fashioned test-pit scheme is as good as any, provided the system is well equipped with valves. The test-pit is nothing more than a manhole of convenient size, built around a gate. On either side of the gate and within the manhole a tap is made and corporation inserted. This furnishes the foundation for a by-pass around the gate. In the by-pass a meter is set, its size dependent on the consumption of the district to be tested. If the section is a large one, necessitating larger than a 2-in. meter, it is well to make a supplementary by-pass with small meter around the larger one. The section to be tested should be carefully laid out, all gates located beforehand to eliminate delay, and tested for tightness. The test for a leaky gate is simple. Close the gates to be tested and open a hydrant on the line between, removing the suction cap. Then open one valve slightly until the water in the hydrant barrel rises to the level of the suction nozzle and just flows out. Then close the valve again. If the water continues to flow from the nozzle, one of the valves must be leaking. Of course, for a few minutes, the flow might be from the houses in the district, but this should stop shortly. If the level of the water lowers, it shows a leak somewhere in the cut-off section, below the level of the hydrant nozzle; but it would indicate a good-sized leak, as the open hydrant removes all pressure from the line. Aquaphones may be used on each gate, as further tests of tightness. The best hours for the actual testing are from 1 to 4 A.M., when the flow is less than at any other period of the twenty-four hours.

If all the gates are tight, it is evident that no water can enter the section so cut off unless it passes through the meter on the by-pass. If readings of the meter are taken at set intervals, and gate by gate the area of the section covered by each test-pit lessened, it can be seen with ease that the leak will be discovered to be between a certain pair of valves. After its general location has been determined in this manner, the exact point where the water is escaping can be determined by looking for any luxuriant growth of vegetation at the side of the road, by dampness on the surface of the street, by driving down a bar and noticing any moisture on removing it, by means of an instrument magnifying the hissing sound of escaping water or by using any other convenient method. In this manner, a whole city or town may be covered.

The instrument just mentioned is contained in a small, light box. A small four-leg brass table is set on the ground over the pipe in the vicinity of where the leak is supposed to be. The box has a raised bottom, so that it may be placed over the table to keep out foreign noises. On the table is a microphone-detector with wire connection to an amplifier battery contained in the box. Very sensitive ear receivers are wired to the battery. When the instrument transmits a rushing noise to the ears, it is evidence that the leak is close at hand. The affair is set at different points along the pipe line until the point where the noise is loudest is reached. The leak will be found directly under this spot. Used in connection with a wireless pipe locator it will be found to be satisfactory.

The beauty of the test-pit scheme is that it is permanent; the pits are always ready in time of need. If it is not desired to construct the manholes, the same results may be obtained by connecting two hydrants with fire hose, one hydrant being inside and the other outside the district to be tested.

Another method, quite as accurate, but probably more complicated and requiring more delicate apparatus, is the use of the Pitometer. There are also several special methods. One was described before a meeting here some years ago, by F. J. Hoxie, called the " caustic soda method." Another is a special device making use of water hammer. It works on the principle that the sudden closing of a valve produces an impulse which travels through the water in a wave, decreasing in intensity in passing an opening in the pipe. It is claimed that the relative distances from the instrument to the break and to the suddenly closed valve is readily determined, but with what accuracy I cannot say.

From our experience in Milton, we believe the test-pit method to be as accurate as any, and simpler than most. It proved its value this spring when we found our daily consumption, which had been away above normal all winter on account of water being run to prevent services freezing, was not at all reduced when mild weather set in. We were using at the rate of 500 000 gal. daily, which was 56 per cent. above normal. The leak was discovered in short order, the average daily consumption reduced 180 000 gal., and the night flow reduced from 20 gal. to 10.

DISCUSSION.

THE PRESIDENT. The paper is now open for discussion. It presents a fruitful source of work and inquiry.

There is one thing that I have been impressed with in the discovery of underground leaks, and that is the necessity of having a particular crew of men educated to do the work. I find all the difference in the world between an experienced crew and one that is not experienced. And I find that certain men can be developed by sort of an instinct inherent in them to find underground leaks, having a better sense of that work than other men who are apparently just as capable. Possibly one illustration may show that difference in the characteristics. We had a leak in Philadelphia, on Chestnut Street, that showed water in the cellar of one of the banks not far from Broad Street. It existed there for weeks. We sent three or four different sets of men, and nobody could discover where it was. We had conclusive reports, apparently, that it did not come from the city water, and yet the leak persisted. We could not find any leaks in the sewer pipes; the drainage seemed to be complete. And finally it was found to originate from an old wooden water pipe that had been out of commission for over a hundred years but had been left in the ground. There was a stretch of 300 or 400 ft. of this old wooden pipe which terminated near the bank building, where the water was found in the cellar. And the drainage from the building where this pipe started had been run by some malicious plumber into the open end of this old wooden pipe. In coming out of the building he had found the open end of this pipe and thought it was more convenient to attach to it than to go into the sewer, so he turned his drainage into this pipe and let it run where it would. It ran 300 or 400 ft. through this old wooden pipe and got into the bank cellar. Of course the water bureau was blamed because the water came from a water pipe, even though it originated with a sewer pipe. It was a case of the sins of the fathers being visited upon the children because they failed to take that pipe out, and even though sewage had been put into it the water works was blamed.

MR. J. M. DIVEN.* In Troy leaks frequently occur in old, abandoned services. The old services are shut off at the curb and the frost gets into them there. The cold weather causes quite a number of leaks of that kind.

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* Superintendent, Water Works, Troy, N. Y.

MR. HEFFERNAN. I should like to hear from any superintendents who have had experience with either the pipe locator or leak detector. On the whole, I have had pretty good luck. The first day I had the instrument I discovered a leak in a private service, 300 or 400 ft. long. The soil was of a gravelly nature, and the leak did not show on the surface. After determining the line of the pipe with the locator, we followed it along with the leak detector. I indicated to the laborer the spot where I believed the leak to be. When dug, the leak was found to be directly under the spot I marked.

MR. GEORGE F. MERRILL.* We have had very good success with the detectaphone, and also by driving a bar through the paving or macadam, down to the pipe, so that we could get a contact and could follow a leak up very closely. This is simply an instrument carried in a box having a small dry battery, and works on the principle of a submarine valve. It magnifies the sound very greatly. If you lay an ordinary watch on a table, this machine will pick up the tick or the vibration of the tick on an ordinary table eight feet long and detect a vibration.

MR. DIVEN. Has Mr. Heffernan or any one else had experience where water from leaky mains was carried in a duct to a considerable distance, finding an opening there?

MR. A. E. MARTIN.† There is a question we are interested in at Springfield. It is not more than a month ago that the railroad people notified us that there was water in their manholes in a certain street. We investigated it, and followed that water back more than a half mile to a place where there were four branches — the main pipe branches each side and then in a little way there are two branches off one of the side connections, and we suspected the leak must be in that region. The only way we could detect it was by the rod which Mr. Heffernan spoke about, — driving it down through the paving and finding the wet spot. We thought we had discovered it, and it finally proved that we had, but we had to shut eight gates around that leak before we could repair it. I think the rod has proven the most satisfactory of anything we have, to detect leaks. We use the detectaphone a great deal and have the aquaphone, too, but have used the detectaphone more. When leaks are reported we go into the ground with this rod, and ninety-nine times out of one hundred succeed in finding them. This leak proved to be right in the branch, and while there was no special sound — the leak apparently was such that it could not be detected by sound — but knowing it might be there we drove the rod down and found the wet spot. In digging for it there were two ducts, one branching out of the other at a very acute angle, and we had to go down between the ducts and come in under to the side of it. The duct was about five feet wide. And just at the further edge of it we found the leak in a T in the main pipe. It was some little job, being in clay soil, and took about twenty-four hours to dig it up after we found it. So our experience has been more in favor of driving the rod, — the divining rod you might call it, — to find the leak after we have cornered it with the detectaphone.

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* Superintendent, Water Works, Greenfield, Mass.

† Superintendent, Water Works, Springfield, Mass.

MR. WILLIAM NAYLOR.* I have just received one of these locators, and tried it on the street where I suspected there was a leak. The funny thing was that it seemed to indicate a leak all along that street. I was wondering if Mr. Heffernan could tell me why I got sound all along the street. There was one peculiar thing about that leak. The pipe runs through a brook, and I have no doubt the water in the brook was running over the pipe and making more or less noise on it. Whether or not that would cause that sound all along the street, I would like to know.

MR. HEFFERNAN. I think that is probably what the trouble was. In order to use the machine successfully, you must have a very quiet day, with little wind. Of course it is a pretty delicate affair. Everything must be favorable and very quiet, or you will get foreign noises. I wrote to the manufacturers about a case in Dedham but could not get a satisfactory reply from them.

MR. NAYLOR. How far, in your experience, could you find a leak with this locator?

MR. HEFFERNAN. I have tested out 400 or 500 ft.

MR. NAYLOR. How far could you hear?

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* Superintendent, Water Works, Maynard, Mass.

Mr. Heffernan. I could hear it practically the whole length of the service.

The President. Mr. Heffernan, do you find any difference in the hearing of different people? Do you find that one man can hear better than another?

Mr. Heffernan. Oh, yes. On this machine I would have probably three men listen. I think my hearing is pretty good, so that I generally depend upon my own hearing to make the sounding.

The President. That has been my experience. Personally I can't tell a leak from anything else.

Mr. George E. Gornley.* We had an 8-in. main going through a large stream from a pond. We knew there was a leak in the hydrant below, and put the machine on and about a dozen different ones tried it. After we had repaired the leak at the hydrant we got the same effect. Then we went to work and put in a cofferdam and held back the water, and had no sound from that. We have had very good luck with the machine out our way. We found one very bad leak in the main. It was on the side of the main, and the water ran about 300 ft. before it showed. There was a very excessive flow of water there. Some days it would go 250 000 gal. above normal. It was necessary that something be done, and all hands started in, so that we were able to find a great many leaks. We have two of those detectors, and had got down very close to normal conditions by the first of September. Now we are having a great deal of trouble with our services, and found a leak this morning, which showed up about 80 ft. from where the leak occurred.

Mr. H. D. Gedley.† Sometimes, I think, the fault is with the machine. In my case the first time I tried to use the pipe locator I thought I was getting results all right, and all of a sudden I could get no sound. I let one of the other men try it and he couldn't get results. Finally, after trying a long time, we got the agent who sold us the pipe locator, who was very sure the trouble was that we didn't know how to use it. We let him try it and he couldn't make it work any better than we did. Come to find out, there was a broken connection in the ear-piece, and when that was connected it worked all right. The fault was with the instrument.

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* Water Commissioner, Abington, Mass.

† Superintendent, Fairhaven Water Company, Mass.

Mr. Samuel A. Agnew.[*] While I have not had this new detector, I have received a great many advertisements of it. I have looked with longing eyes at the instrument, wondering whether it would do what they said it would. I have had the old detector and I have always had the aquaphone. Now, most of the leaks that I am troubled with are on the beaches. My experience with the detectaphone is that I can hear the waves rolling up on the shore; and personally I am like Mr. Davis, — I am no good on the job at all. My son seems to be more successful in finding leaks, but in his experience he always found the aquaphone better than the detectaphone. Why, I do not know, except he would always go back to the old aquaphone. The method we use almost invariably is to go along the street and open the service boxes. It is quite a job, to be sure, — especially when you find the service boxes full of sand. But we listen as we go along the street at the various service boxes, and in that way we can ordinarily determine somewhat the locality of the leaks. I am pleased to know that the new leak finder is successful. I don't know whether it is new or not; it is advertised quite widely at the present time. I have not bought one, as I wanted to know something from others' practical experience before I invested. While the detectaphone was supposed to be better than the old aquaphone, we did not seem to get as good results from it as we did from the aquaphone, — possibly because it magnified the sounds that we did not want to hear. We have always used the aquaphone and with very good results.

Mr. Gifford.[†] I should like to mention cement-lined pipe in connection with the pipe detector. I have had a little experience and should like to hear from others in regard to the use of the pipe locator on cement-lined mains, — not services.

Mr. Martin. I can't tell anything about a pipe *locator*, but I *can* tell about trying to thaw out frozen service pipes. In any cement-lined main we have in Springfield, if you attempt to thaw it with electricity you will get stung. You might as well not try.

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[*] Superintendent, Water Works, Scituate, Mass.

[†] Superintendent, Water Works, Dedham, Mass.

While once in a while you may find a joint in it which will carry the current through, the next one won't, and you will not get by. We tried one of the new leak finders and had the same experience that this gentleman had with the detectaphone, — that it amplified sounds that we did not want to hear, and the consequence was that we couldn't make the thing work as well as the aquaphone and the detectaphone. We corner the leaks as well as we can in the way he speaks of, — by listening in service boxes and gate boxes along the line. In that way follow it to a point where we think it probably is, then we try the rod and generally find the leak.

Mr. Gifford. My experience with the pipe locator on cement-lined mains is that while I swore by the pipe locator before, that day I swore at it. I had a leak on the line and wanted to locate it. One of my men told me the location of it but I did not agree with him. I put the pipe locator on, and located the pipe on the other side of the street. The man swore it was not there, and I told him I was sure it was there, that the machine could not be wrong. They dug down there and found a gas main. The next day I went into two houses and found both houses were connected up with Ruud gas heaters, and the current had evidently passed around through the iron pipe and located the gas services rather than the water pipe.

Mr. Agnew. I had a very bad leak. We finally determined that it was around a certain gate, but could not find it. We dug pit-holes and drove down a bar, and did everything we could think of. Finally we dug around the gate and put in a meter, but it did not show any leak at all. We could hear the singing very plainly. We went up the line, which, after leaving the beach stones, went through a heavy clay or sand, and did not seem to hear the sound as plainly, but it certainly was not beyond the gate, because the meter would have shown it. The first thought was that the gate was not releasing itself, because we have heard where water, instead of passing through the meter, went through a leaky gate. It was not there. Finally we went back up the line, probably two hundred feet, and found an old connection which had been used years ago for filling a standpipe and that old pipe had broken off. Now, that was a very baffling thing to us, and the trouble was that a couple of weeks before we really located the leak way up the line and all sounds indicated it was beyond the gate.

Frederic I. Winslow.* The paper and discussion suggest a paraphrase of Kipling, " There are forty ways to find a leak, and every one is right." I call to mind three distinct leak cases on the Boston water system some years ago. The first was one of considerably over one million gallons per day, and indicated that a gate had been left open between the high and low service. On careful investigation, however, no such gate could be found, and as all these gates were carefully recorded and were comparatively few in number, it was not a difficult matter to settle the question. Meantime the leak continued, and it was finally decided to use the Deacon meter system, a part of which was still in use in that part of the city. It so happened that this section was so situated that it could be shut entirely off without interfering with the flow to other portions of the city. Section after section was shut off at night until the search was narrowed down to a very few blocks, when, as one of the workmen stepped on a blow-off gate, he felt a quivering of the cover. It was speedily opened, and the gate was found to have been left open and was discharging into a sewer.

The second case was on a large main which was noticed to slowly empty when the gates feeding it were shut and an air-cock opened. As there were no immediate takers on this line it was decided to cut it and connect the two capped ends with a small lead pipe and meter. This showed on which side the leak was; then that section was cut in two and the action repeated. In digging just beyond the limits of this work, a cock was found in the ground and a corresponding hole in the pipe, so that this leak had in all probability been in action for many years.

The third case was where a leak appeared in various cellars some weeks after a pipe near by had been re-laid. A number of tests were made, involving shutting off all the mains in the vicinity at night, but the leaks continued until damages for a ruined house were sought.

Finally, after every cellar in the vicinity had been re-examined, save one which never could be opened, and nothing found, it was determined to enter this particular cellar; and it was then found to be the only cellar in the neighborhood completely filled with water, and, as this cellar was beside the re-laid main, it was decided to pump it out, when there was found an open end of a pipe which a foreman had carelessly connected or re-connected to the new main, forgetting that it was shut when he found it on the old main.

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* Consulting Engineer, Boston, Mass.

It must not be forgotten that the stopping of all waste of water, while always an important problem, has now become doubly so, and it is not improbable that if the various municipalities do not at once move in this matter, and it is very certain that not all will do so, the matter will be taken up and enforced by either the state or the national Government, to the end that fuel may be conserved.

THE FUEL SITUATION IN NEW ENGLAND.

BY PROF. IRA A. HOLLIS.*

[*September 11, 1918.*]

PRESIDENT DAVIS. Mr. Storrow, the New England representative of the Fuel Administrator, has gone to Washington. That means that New England will get more than its share of coal, and will receive coal which was destined for other parts of the country. [*Laughter.*] That is the reputation that the New England Fuel Administrator and his associates have in other than the New England States. We outside of New England can only hope that Mr. Storrow will soon represent the water works, irrespective of locality. Mr. Storrow has asked Prof. Ira A. Hollis, whom we may say is one of us, the engineer in this state for the Fuel Administrator, to come here, and he will tell us of the fuel situation in New England. I have the pleasure of introducing Professor Hollis.

PROFESSOR HOLLIS. *Mr. President and Gentlemen,* — I am quite sure that Mr. Storrow regrets very much that he had to go to Philadelphia yesterday afternoon and subsequently to Washington on the fuel business. I do not agree that every time he goes to Washington there is an increased allotment of coal for New England. It is like the swing of a pendulum, — sometimes there is a decreased allotment and sometimes an increased. His visits to Washington are usually consequent upon a decrease which has been made in his absence, and he hastens to Washington to get our allotment restored.

He was to speak here on the fuel situation in New England. Of course, when you take the word "fuel" technically, it means anything that will produce heat when combined with the oxygen of the air; but we are far more concerned with one kind of fuel than we are with all kinds, and it is the coal situation in New England that is important to us. People have said to me, as I have gone about the state, " Why not cut a lot of wood to replace coal? " Did any one of you ever make an estimate as to how much wood would have to be cut in New England in order to replace the coal that this part of the country receives in the course of a year? It would be 60 million cords. I think that would supply a pretty large army in France. We cannot afford to cut wood in any such quantities as that to replace coal. We can afford to cut it only as a form of insurance to tide us over those periods when there is an interruption in the flow of coal to this part of the country. So I shall confine my remarks, excepting in brief part, to the subject of coal.

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* President of Worcester Polytechnic Institute and Engineer for Fuel Administration of New England.

One thing I have observed in going about the state, — and I have been to all parts of the state during the past two months, speaking to manufacturers, to fuel committees, and, in fact, to anybody who would listen, on the subject of conservation and how to reduce the demands for coal in this state, — and that is the fact that there has been a steadily growing optimism on the subject of the supply of coal. Only last night I was talking to a large body of men in Holyoke, and a gentlemen said to me, " Well, I suppose we have plenty of coal now, because the Fuel Committee finds it difficult to procure purchasers for the coal that comes in." We have an excellent example of that in Worcester, because fifteen carloads of coal came into Worcester the other day in box cars, and actually they couldn't find any place to deliver it except to one company which carried it into its own yard and thus provided itself with an entire year's supply. One of the principal problems, however, has related to getting labor to unload the coal. That kind of a phenomenon has given rise to the belief that we have gone over the top with regard to the supply of fuel for the coming year; and my object in coming here this afternoon was to answer the question I have heard so often put throughout the state, " Have we got by the difficulties of the coal situation in New England? "

I want to say here emphatically that we have not gotten by the difficulties; that there is the same hazard with regard to the future that there was two months ago. A recent order issued by the Fuel Administration in Washington has covered up the real facts of the case, despite the fact that we need more and more coal all the time. I am going now to try to state just exactly why it is that there appears to be plenty of coal, and then to state why it is that we haven't it.

There are two aspects of the coal supply. One of them is the mining of the coal itself. Mr. Garfield and others who have investigated the subject say that there will be no difficulty in getting plenty at the mines. I cannot say as to the correctness of that statement, because there is fluctuation from pessimism to optimism in Washington. One week there is plenty of coal and the next week there isn't. I do believe, however, that there is sufficient evidence to warrant the statement that the amount mined this year will exceed that mined last year by, perhaps, 80 million tons. But the demand for coal in the manufacture of everything that goes to supply those sons of ours on the other side, and to the making of an effective army, exceeds the increase in the amount of coal mined and available at the mines, so that, instead of coming out ahead of the game this year, we are behind, and will have less coal than we actually need, unless by some method we can cut down by our savings the amount demanded. The supply from the mines, then, is supposed to be reasonably certain.

Another aspect of the coal situation relates to its distribution. I heard a lecture before the United States Chamber of Commerce, about three months ago, on conservation, and I afterwards told the gentleman who delivered the lecture that he had balled the thing up entirely, in treating conservation as if it meant elimination of industries and a saving of coal in that way. That is not saving coal at all; that is destroying industries, which is far from being the same thing as decreasing the demand for fuel. I divide the subject, first, into the mining of coal and, next, into this question of distribution, and it is in the distribution that the chief difficulty lies here in New England.

At the risk of boring you, perhaps, to extinction, by telling you what you already know, I will say just a word about how the coal comes into New England. It is estimated that 30 million tons will be needed to get us through the winter, — I am speaking of all New England, now. About 10 million tons of that comes through what are known as the gateways, and 20 million tons come from tide-water. That means that 10 millions can be hauled in by rail and that 20 millions, to make up the 30 millions, must come by water from Norfolk and the other places down the coast, to which the coal is delivered from the mines.

Now, the amount of tonnage required to haul in this coal from tide-water, or to move it, is in the neighborhood of 400 000 tons. That is, if all the barges and ships made one voyage from tide-water ports to Boston, where the bulk of the coal is delivered, they would deliver 400 000 tons of coal. When you consider that they are going to bring 20 million tons, and that it takes 400 000 tons of shipping constantly on the move, without any interruptions at all, to bring in that amount for us during the year, you can realize that there is a considerable amount of shipping that must be plying the ocean along our coast to keep New England supplied.

The year for the coal supply begins on April 1, and not on January 1, and on April 1 there was a great shortage of shipping required to bring the coal in. The tonnage has been steadily increasing, however, until on July 1 there was something like 400 000 tons of shipping available, and at the end of this last month, August 31, there was roughly 500 000 tons — about 480 000 tons — of shipping, thus assuring us sufficient tonnage to haul in our coal. It has been discovered, however, in the last week, that the regular supply of coal to New England has been seriously interrupted at tide-water by the fact that coal has been diverted to another section, and that we have had a lot of ships down at Norfolk eating their heads off, simply waiting there, with no coal to haul. Mr. Storrow, with great good sense and good judgment, has told the Government that he would rather surrender those ships and have them doing some war work than have them waiting there until the flow to New England can be resumed, and so he has surrendered 100 000 tons of shipping, thus leaving us now with about 375 000 tons when the flow begins once more.

There is another subject to which I would like to call your attention. A good many comparisons have been made between the year 1917 and the year 1918. It is impossible to make a satisfactory comparison between them because in the former year there was a great amount of coal in storage. I have heard it estimated that there were 9 million tons in New England; and the falling off in the supply of coal to New England caused by diverting coal elsewhere was not then a serious objection, as we could draw on our reserves. That is exactly what we did last year, and we got through very comfortably, or reasonably comfortably, because we were drawing on our reserves. I cannot say as to the truth of this statement, but I have understood that the investigation of the Fuel Administration has shown that the reserves were exhausted by the first of April this year, so that we had to start anew without any reserves. That means that the delivery of coal in 1918 must be far greater than in 1917, even to bring us up to what we had in 1917, so the statistics of the relative amount hauled in 1917 and 1918 are very misleading. I speak of that because I have a sheet here showing just how much coal has been hauled in every month, and I want you to see exactly where we stand in this business.

I want to say, however, that I am not speaking of this in criticism of the Administration, because we know perfectly well that to change a great country like ours from a condition of peace to that of war has necessarily made a serious disarrangement of everything. I have criticized the Administration many times for being too slow, yet God knows that in some respects they have accomplished a miracle. I do not speak of their cutting off the supply of coal in criticism at all, but I am merely reciting it as one of the facts of the case, so that we may understand the necessity for us to cut down our demand for coal as much as possible, and in that way help our great country at this time.

It was the judgment of the Administration that the best way of getting this coal into New England was to make speedy use of the summer months, when there would be no interruption on account of ice and not likely to be bad weather. So it was agreed to supply New England from the first of April for six months thereafter at the rate of 3 million tons a month, with the expectation that during the next six months the coal would come in at the rate of 2 million tons a month, recognizing the delays and detentions that would arise on account of cold weather. Consequently, in judging as to our supply at the present time and its relative sufficiency, it is not right to compare 1918 with 1917, but we ought to compare what has been delivered with that which we are going to need when the time comes. The criticism I started to make a moment ago was of the fact that the Fuel Administration advised everybody in New England to lay in their supply as speedily as possible, while the going was good. They have advised people to do that all over the country, and especially in New England, because the haul here is seven hundred miles, far greater than to most of the other places which are supplied with coal west of the Hudson River by rail; and by water it is still greater. They advised us, and wisely, I think, to lay in our coal supply. But after having done that, a few days ago they issued orders limiting the amount that one could have on hand in storage. You can imagine the position of a company in Worcester, for instance, — and I am stating an actual case, — that obeyed the request of the Fuel Administration and laid in enough coal to last them for four months. They had one hundred and twenty days ahead. Now comes out the order, about fifteen days ago, saying that war industries may have a storage of coal for only sixty days, and non-war industries a storage of for not over thirty days. In other words, all those people who have laid in and have in stock more than enough to last the sixty days have got to wait before they can get any more coal. It doesn't make any difference how the coal is coming in, we have got to find some way to dam the flow and, perhaps, damn the order for the position it has put us in, because we had previously been urged to put in our full supply and now find ourselves cut down to sixty days' reserve. That is why thousands of tons of coal come into our cities, and appear to go begging. It is because people are not allowed to have it.

Now, when you think that we want to bring in 3 million tons a month in order that we may have something in reserve when cold weather comes, so that the detentions from ice and storms may not deprive us of coal in the winter when we can get only 2 million tons a month, when we receive an order that limits the supply so that we are certain to suffer in the winter whether we like it or not, it gives us some anxiety that ordinary people who know nothing about the coal situation do not have. They see great piles of coal in the city and can hardly realize that there is a shortage.

Here are the actual statistics. In 1917 the amount of steaming coal which was hauled in by the end of August over the railroads and brought by water was 11 122 000 tons. At that time there was probably 8 or 9 million tons in storage. The amount hauled in in 1918 up to the same date, during the five months, was 13 000 000 tons. That is estimated, but probably it is right, inasmuch as the complete data could not be brought up to date quickly enough to give us the latest information. That, gentlemen, is an apparent gain of 2 million tons of coal. But is it a real gain in the supply of New England, when you consider that the reserves are burned up? Far from it. On August 31 of this year there should have arrived in New England, in order that we might have coal to take care of us this winter, 15 million tons, which is 2 million more tons than actually arrived. In other words, we have 2 million more tons than we had last year, but we are still 2 million tons short of what we ought to have. I don't know what ultimate effect this order about the sixty-day reserve is going to have, but this represents the bituminous coal situation at present.

Now, as to anthracite, what is the situation? The data in regard to that I cannot bring up to date, but I can give you some idea, up to the end of July, anyway. Our limitation now is two thirds of the amount of coal we had last year. On that basis we are all right up to the present time; we are getting in about the amount of coal we ought to have. The amount actually brought in is 4 550 000 tons at the end of July. I cannot give you the statistics at the end of August, but I think we have the amount required in accordance with the two-thirds schedule. The required supply is 4 600 000 tons, so we are pretty nearly up to it. I am inclined to think that before the winter is out the anthracite in a good many of our homes is going to be pieced out with the bituminous coal, as was done last winter to some extent. But I have been trying to spread this gospel through the state, namely, that the cutting of wood and the purchase of a couple of cords of wood is a wise insurance against our situation later. Furthermore, it is a certain measure of economy in getting us through the chilly days of the fall and spring without burning coal when wood is a little more economical, perhaps, than coal, if we use it wisely. My advice throughout the state in regard to this coal situation has been that every family who can afford it ought to have in the cellar a couple of cords of wood. I heard an old Irish-man who lives near me say the other day, "If I only had a pig hanging in the cellar, and some heads of cabbage and potatoes, I shouldn't care for anything." I have been preaching the gospel of two cords of wood, and I think that gospel ought to be spread.

That is all I have to say on the subject of distribution, gentlemen. Because, after all, the problem of New England, and the thing which makes it peculiar and different from any other portion of the country, and the thing to pound into the Administration in Washington, is the fact that New England is remote from the coal fields; the haul is anywhere from 300 to 700 miles greater than to any other part of the country east of the Mississippi, and that is what makes it a great problem. That is why they advise us to use anthracite screenings, because the anthracite is closer to New England than the bituminous coal. And there again you run across some very curious things in connection with distribution of anthracite. Some of my friends in Holyoke, having been strongly urged to use anthracite screenings as a method of saving bituminous coal and reducing the haulage, so that the cars could be moved more rapidly, changed their station over into one which would burn anthracite screenings entirely. After they had got well started they received a new interpretation of the regulation which put the sizes of anthracite screenings that they were using into the domestic class, and they can't get any of it now. I presume that will straighten itself out, however, after a time.

Now, the next thing I want to say relates to another side of the fuel situation. How can we manage to live on the coal that will be given to us? How can we trim ourselves down to the minimum in New England? I might say, by organization, putting into every factory its own fuel committee made up of its own employees, and trying to create that moral attitude of mind toward saving which would cut out every unnecessary electric light and save every bit of fuel; and I think there is, perhaps, a reformation taking place in the state along that line. I see it everywhere. I have been to every city in the state to speak on the subject of how to reduce the demand for fuel. And there, again, gentlemen, there is a confusion in the minds of the Administration as well as in the minds of the engineers. Conservation means the saving of waste, the more efficient use of the heat that is produced by the combustion of fuel. We cannot use that word as synonymous with the elimination or shutting off of industries. If we shut off an industry it will come again, and we want it to come again. That is not conservation at all. It is merely reducing the demand so we can get through the year or get through the war without suffering. Another thing that is wrongly considered as conservation is providing substitutes for coal. But that is not conservation at all. To cut a cord of wood to replace coal reduces the demand for coal in New England and helps us through the war, but it is not conservation. The use of water-power, the use of gasoline or petroleum, is providing a substitute. It may be a long-time substitute, and we may find after a while that we can provide enough substitutes to save a lot more of the patrimony which God has given us in America to be handed over to our children.

Conservation I take to mean a reduction in the amount of waste, and, in order to accomplish that, we as engineers — I mean by " we," Charles T. Main, and Safford up at Lowell, and Joe Skinner at Holyoke, and Gilmore at Fall River — have agreed to serve with the Administration as an Advisory Board on the subject of saving. We have gotten out two or three pamphlets, — " bulletins," as we call them. They are nothing great, because we have tackled the thing entirely from the common-sense standpoint. We felt that it would be foolish for us to go into the industries in this state and insist on their making great changes at the present time. In the first place, they couldn't get the machinery with which to do it; and, in the second place, there isn't time to do it. What we have done is to make the attempt to have every industrial plant and factory in this state inspected, with the hope that we could assist, through the organization of committees of their own and by advice, in reducing the amount of coal used with the machinery already installed.

And I want to say to you, gentlemen, that as engineers it is sometimes humiliating to think how wasteful this nation has been, and to think also how in some respects we ourselves have fallen down as engineers. I have one case in mind at the present time. When we began last December, I talked to the manager of a certain concern on the subject of waste. He appointed a committee of five, representing the different departments of the factory, — there are twenty acres of floor space, — and they went ahead and studied the question of waste in their plant, not by calling in a consulting engineer at all, but simply by going at the matter as a plain, common-sense proposition. They had weekly meetings for conference and to decide what would be done the next week. Last December they used in that factory 950 000 lb. of coal. They worked steadily at eliminating waste through the factory, not in the combustion of the coal, — they made very, very little change in the fire room, and they covered some of the piping, — but by studying the actual use of the power after it got out of the engine room, and of the steam after it got away from the fire room, throughout the factory; and they gradually reduced the amount of fuel used, so that in March, which was a month in which the temperature was very nearly the same as it was in December, they had reduced the consumption of coal from 950 000 lb. to 550 000, — a saving of 200 tons a month. What does that mean, gentlemen? I told their manager, that instead of being commended for that great saving which he had effected I thought it was the saddest confession I had ever heard. They had been going on in that way for years, with that great waste. And there isn't a manufacturing concern in this state where conditions cannot be improved. I can state case after case where such waste has taken place, and mainly outside of the fire room, in the mill and manufacturing departments. And what we are trying to do in this state is to stop that waste.

I have congratulated myself on having Mr. Main backing and helping in this matter. He has been a power for good in the state. I told him if we went about together he could preach coal and I would preach sermons, and I thought we could reform the state. We have been welcomed everywhere, and every engineer I have run across has been anxious to do something. Because, what does it mean — whether there is going to be any shortage in Massachusetts or not — what does it mean to the other side if we can save coal here? Does any one in this room realize that the wounded men in the northern part of Italy last winter had to lie cold in the hospitals? They hadn't any coal to use, and we had no ships in which we could send it to them, and, if we had had, the submarine menace was too great. So the poor fellows coming back from the battlefield wounded had to lie down in freezing rooms. Does any one realize the tremendous amount of coal which is required to supply our soldiers on the other side, and that every pound of coal we save in this state by true conservation — that is, by the elimination of waste in our factories, and I will say in our water works, too, — means a more successful army on the other side?

There is one thing which always comes into my mind when I consider this subject. After all, if we are going to enable our industries to get through the winter by decreasing the demand for coal, if we are going to keep our children warm this coming winter and supply our soldiers on the other side with what they need, it must be because we have a will to do it. Throughout the country people are too careless. I think there is a higher conscience in Massachusetts. I am not a Massachusetts man; I am a Kentuckian; but I have observed one thing which makes me glad to live in this state and to be an adopted son, and that is that there is a high conscience here in regard to anything of this kind. But until our whole people realize that it is upon us that our boys on the other side must depend, we shall not have the will to exert our whole power in taking care of them.

It has been said by the President of the United States that we have gone into this to make the world safe for democracy. It has been said that food will win this war, and that fuel will win this war. What will win the war, gentlemen? What will make the world safe for democracy? It is the blood of our own boys, our own sons, whom we have sent across the seas. It is not food. It is their blood flowing into the fields of France that will make this world safe for democracy. That is the point after all. Sometimes I wonder if we have made a good bargain. I wonder if we are going to bring as many of them back home as it will be possible to bring back. I know that we are going to be victorious. God has written that in the sky, — that right must triumph over might. Nevertheless, are we going to win our victory with as little loss as could be suffered? I fear not, because we are not in that state of mind yet where each one feels that he himself must make a contribution and that it is his duty to think of that contribution.

I have one last word to say in this connection. It is not on the fuel situation strictly, and yet I believe it to be a part of it, because it is the moral aspect of this thing that we must get into our minds if we are to do all we can in saving all that can possibly be saved. That is the psychology of this whole situation. I sometimes wonder what my own boy will say to me when he comes back. I was just saying to Mr. Davis that I had a letter from him yesterday morning, and in it he told how he was pushed off to the side of the road when the 101st Engineers came by, and how he remained at the side of the road until a whole American Division of 15 000 men had passed and 800 motor trucks, rushing up to the battlefield.

What are they going to say to us when they come back? Can we face them fairly with the conscience that we have done our share even in a little thing like the saving of coal? I want to see that great review in Washington, which is going to be spread through the country in the " Movies," when the boys come back. I want to see them, and I know in my heart they will all be there. Every one of them will be there, some in uniform but others in spirit, whose mortal bodies are lying in the soil of France. They will all be there, some seen only through the tears of sorrow, but they will all be there. Shall we have kept the faith? Shall we have done all that we ought to have done in every respect to make the fuel situation safe for them, to make it safe for our children, and bring as many of them home as we can? God help us if we haven't done that, for if we have not we shall never be happy again after they come home.

Thank you very much. [*Prolonged applause.*]

DISCUSSION.

THE PRESIDENT. We are greatly indebted to Professor Hollis for coming here. He certainly has stated the fuel conservation situation in a most thrilling and vivid manner, and brought it home to us in such a personal way that we will never forget it, and will carry the message from this meeting to our own communities, as it will be carried through the publication of the JOURNAL to a large circle of readers.

This telegram comes from Mr. Edward E. Minor, of New Haven. It says:

> "Priority list just published places water works in second class. Water supply, so fundamentally necessary for all human activities, should be in first class. A deferred classification may result in our being unable to obtain coal or other essential material. Request action by the Society asking Priority Committee for re-classification water works in their list. New England water works supply greatest arsenals in the country."

The question is, whether there is any possibility of water works going without fuel because they are in Class 2 instead of in Class 1. Perhaps Professor Hollis can answer that question.

Professor Hollis. I don't know. I do know this much, that any one who wastes water at this time is pretty nearly a traitor to the country. I don't believe in cutting down the water supply of the family to any particular amount. We all want to take care of our children and make of them good citizens. I remember hearing a man saying in a public address that we must give our all, but I don't believe in that. A man should not give his wife nor should he give his children to be public charges. That would be the destruction of civilization. A concession ought to be made to the family before everything else, because the family, after all, is the foundation on which the state is built up. I doubt if it is right to classify water works in the second class, and I don't believe that will remain very long. I don't think you need give yourselves any uneasiness about that, because as soon as there is any little shortage of water they will restore the thing. I shall be glad to answer any question on the subjects I have touched upon.

Mr. J. M. Diven. I suppose it is possible to save considerable coal in the homes. Has anything been done in the way of education in that direction?

Professor Hollis. Yes. I will say this to you, gentlemen. I was very much pleased, the other day, when an old friend of this Association, not a member but a member of the Boston Society of Engineers, came to my office in the State House and said to me: "I don't feel that I am doing all that I ought to do. I want to do something more." "What do you want to do?" I asked. "Well," he said, "I am retired now; I am on a Carnegie pension, but I am still vigorous and I should like to go about this state telling the people how to use coal in the kitchen and in the furnace. I should like to organize something on that line, and I am perfectly willing to address every women's association in the state." I asked him to go down and introduce himself to Mrs. Thayer, who is at the head of the women's organization. She has been communicating with the chairwomen of the various women's organizations in the state, and this man is now about to start out and go into every city and put into the households methods by which the people may be made more comfortable in their homes when it is cold. I was charmed with his enthusiasm and his desire to help. That was Prof. C. Frank Allen, formerly professor of engineering at the Massachusetts Institute of Technology. [*Applause.*]

THE FUEL SITUATION IN NEW ENGLAND, AND NECESSITY OF CAREFUL PLANNING IN ORDER TO GET THROUGH THE YEAR ON A RESTRICTED AMOUNT.

BY CHARLES T. MAIN.*

[September 12, 1918.]

The United States Fuel Administrator estimates total coal demand for year beginning April 1, 1918, at 735 000 000 tons bituminous and anthracite; this is 84 000 000 tons more than was produced last year, and the Fuel Administration does not expect that the increase can be fully met. Fuel Administrator says that 60 000 000 tons must be saved to avert disaster.

REASONS FOR SHORTAGE.

The principal reason for this shortage is that there is not sufficient transportation facilities for hauling enough coal and all the raw materials, food, and other things needed. Primarily, there is not a coal shortage, but a transportation shortage. The railroads must be given all the coal they can handle now. There will be less room for it later.

Another reason is because of the great increase in coal consumption. This increase began before we were in the war. Since we entered, the pace has increased, and it will continue to do so. New war industrial plants are springing up in great numbers. Some of these are colossal; single plants are calling for from one to three million tons of coal a year.

Curtailment will be necessary in many things which have been regarded as necessary. Everybody is going to feel the pinch. Industries must be readjusted. Dislocations and troubles are inevitable all along the line. It is our task to help reduce these to a minimum.

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* Civil Engineer, Boston, Mass.; member of Advisory Committee, Fuel Administration of Massachusetts.

ESTIMATES FOR NEW ENGLAND.

The estimate of the New England Fuel Administration for bituminous coal for 1918 was 33 400 000 tons.

The estimate of the United States Fuel Administration is 30 000 000 tons, or 10 per cent. less than the New England Administration.

Recently the United States Fuel Administration has proposed further curtailments to 25 000 000 tons, on the ground that the estimates of the New England Fuel Administration have been excessive.

Assuming 30 000 000 to be enough, the amount which the railroads can haul is limited to about 10 000 000 tons, leaving 20 000 000 tons to come by water transportation.

The estimated amount of tonnage required for the 20 000 000 tons is approximately 500 000, assuming perfect service, — no allowances made for accidents, wrecks, strikes, difficulties in procuring seamen, and hostile attacks by submarines.

On January 1, 1918, there were only 200 000 tons available, the reason being that the vessels were needed for transportation of men and materials to Europe. The full tonnage required was reached after eight months of the year had expired. It does not require any complicated figuring to see that the 30 000 000 tons will not be delivered.

The reserve storage of last year was all exhausted during the winter, so that we started worse off than usual.

At this time of year, when considerable coal has been stored, to the casual observer it may appear that there is an immense amount on hand and enough to last all winter. As a matter of fact, sixty days' supply is the maximum allowed at present.

PROBABLE DEFICIT.

The indications are that New England will get pretty near its usual supply of anthracite, but that there will be a deficit of at least 6 000 000 tons of bituminous coal, or at least 20 per cent. less than the United States Fuel Administration's estimate and 30 per cent. less than the New England Fuel Administration's estimate.

EFFECT OF SHORTAGE.

This country is engaged in the most stupendous undertaking that any country ever undertook. Some of our citizens do not comprehend this yet. Dr. Hollis says it is not a war to make democracy safe, but a war to preserve the Ten Commandments.

In order to win the war, it is necessary for us to operate our manufacturing plants to the maximum capacity to supply the supplies and munitions which are required in such vast amounts to back up our soldiers and sailors who are standing between us and ruin.

The industries cannot be run full unless there is sufficient power to run them. This power can be supplied from four sources, — coal, oil, wood, and water-power. Of these, coal is the chief supply.

HOW TO GET ALONG WITH LESS COAL.

There are about three ways to get along with less coal.

1. By eliminating and shutting down what may be called the less essential industries — and who shall determine what are less essential? The shutting down of any industry will cause hardship on the owner, employees, and the community in which it is located.

The United States Government has now, through the War Industries Board, established a branch called the Production and Conversion Section, the duties of which are to convert plants the products of which are not essential to the war, so that they will run on war work, thus showing the necessity of using all of our facilities.

The shutting down of any industries is the last thing that should be resorted to.

2. The next way that suggests itself is in the use of substitutes for coal. Considerable oil fuel is now used with satisfaction in New England; but this again is a transportation problem, and the fuel oil companies will not take any more contracts so long as the conditions are as at present.

Considerable quantities of wood have been cut within truck hauling distance in some towns and cities. The local fuel committees are strongly urged to encourage the early cutting of wood in their districts, so that it can become dry for use in the winter, dry wood being of considerable more heating value than green wood.

Hydro-electric power can be substituted with advantage and saving of coal in some instances, but the hydro-electric companies in this state hesitate or refuse now to take on additional business, as their plants are fully loaded.

Steam-electric power might be substituted in some instances in plants using relatively small amounts of power, and where there is no use for exhaust steam, or in summer time when there is no heating.

The great bulk of the water-power plants in New England have old and inefficient wheels, in poor settings, and of a capacity to use all the water in the stream for about six to seven months in an average year. Many of these could be improved and increased in capacity in a reasonably short time, so as to get the benefit of the improvements before the time of stress is over.

3. The third method of getting along with less coal, and the one that we are most interested in at present, is to study and analyze the various possible losses and reduce these to a minimum.

The people of this country are a wasteful people in many ways, in the use of hot water, in the waste of cold water, in the consumption of foodstuffs, in our clothing, with our automobiles and in our processes of manufacturing; and it is a pity that we should have waited until the stress of war should have caused us to give some heed to these wastes.

Cost of Power.

In nearly all lines of manufacturing the cost of power has been such a small per centum of the value of the output that it has received secondary or no consideration in many plants.

In electric light and power plants which sell current, the whole cost of the current is the value of the product, and of this approximately 60 per cent. is coal. The same conditions prevail in pumping stations, where the full product is water pumped. In most of these plants records of operation are kept and an endeavor made to keep up the efficiency of the plant.

PLAN SUGGESTED.

The plan which the local fuel committees are requested to inaugurate is the setting up in each manufacturing establishment, where fuel is consumed, a fuel committee of its own employees, whose duty it shall be to see that the coal is consumed economically and power is produced economically, and that there shall be no waste of steam and power throughout the plant.

The numbers and character of the committee would vary with the size of plant and kind of work done, and it can be assisted by as many persons as seems desirable.

ADVISORY ENGINEERING COMMITTEE.

An Advisory Engineering Committee has been appointed by the Fuel Administration for the purpose of assisting the local fuel committees in the various towns and cities in getting these plant fuel committees organized and started, and the engineering committee will enlist the services of other consulting engineers to give general advice where needed. These engineers, however, cannot be expected to make exhaustive studies and reports without pay.

The Advisory Engineering Committee has prepared a pamphlet in which is pointed out the many places where wastage may occur, with suggestions to prevent these wastes. It has also outlined the method of organizing the plant fuel committee and suggested the duties of the members.

It has also suggested forms for records of performance and accomplishment.

As this work must be very general in its nature, and will not be applicable to every plant, variations should be made from the suggestions to suit the local conditions.

WHAT ARE THE REMEDIES?

In order to avert disaster during the coming winter, there must be accomplished at least three things:

1. A better organization of the transportation facilities which we have. There is little chance for further improvement of these facilities, for the railroads are under physical limitations

of car production, and the shipping facilities are most urgently needed for transportation of men and supplies to Europe. The only hope of avoiding another serious coal situation next winter is along immediate action along the other two lines.

2. The second is the more careful preparation of coal for shipment in order that heat-producing coal shall be delivered and not incombustible material. It is stated that 72 000 000 tons more coal was shipped last year than would have been required with coal of an average quality. *This is one of the causes of the transportation difficulty last year.*

I have been informed that the Government has placed inspectors at the mines, to prevent a repetition of this.

We have no control over 1 or 2, and must therefore devote our attention to the third remedy:

3. Economy in the use of coal, and prevention of waste in the use of power and steam.

" It is . . . important to impress upon the manager of every industrial enterprise that it is his personal duty to see that his plant gets just as much out of the coal it buys as is humanly possible.

" It is up to every one of us, whether we are manufacturers, professional men, coal operators or dealers, to immediately take stock of the situation and turn energetically to the problem in hand, — the problem of shaping the habits of the future so as to avoid the sad experience and mistakes of the past."

Fuel and Power Committee for Water Works.

You may say that the plan of a " fuel and power committee " which is being established in the manufacturing plants is not applicable to pumping stations, and that you have always endeavored to run at the maximum efficiency. This same statement is made by some of the manufacturers, but there is no plant which is one hundred per cent. efficient, and in many plants which have been considered as remarkably good there have been made considerable reductions in coal consumption.

You may also say that you will obtain all the coal you need to run, as it is absolutely necessary that the water supply be not shut off. This is true, but every pound of coal that can be saved will be so much more available for use elsewhere and will help in stabilizing manufacturing which is vital to the country at this time. There is also the incidental saving in cost of operation, which is worth consideration with the present high fuel prices.

An extra effort should be made at this time to prevent wastage of water by leakage and in the houses and elsewhere.

Every water-works plant using fuel or purchased power might form a "fuel and power committee" on similar lines to those established in manufacturing plants, the personnel and duties of which are outlined in the attached diagram; the size and scope of work to vary with the size of the plant.

EXTRACTS FROM BULLETIN NO. 1 OF THE ADVISORY ENGINEERING COMMITTEE.

(Some of these have been slightly changed to suit water-works practice.)

METHODS FOR SAVING COAL — DETAILED SUGGESTIONS.

In the Boiler Room.

Make a record of observations. Boiler efficiency cannot be increased without knowledge of what is being done. In order to figure the evaporation (pounds of water evaporated per pound of coal) the following data are needed:

Weight of coal; also per cent. of ash.

Weight of feed water pumped.

Boiler pressure (also temperature of steam if superheated).

Temperature of the feed water at its source and entering the boilers.

Temperature of the flue gases after passing through boiler or economizer.

Percentage of carbonic acid in the flue gas, if possible. This item is a good index of the amount of heat wasted in the gases sent up the chimney, due to incomplete combustion.

Number of heat units in a pound of coal ought to be known, but in this emergency it will hardly be feasible to have tests made except in very large plants.

Stop up cracks and joints in the boiler settings, to prevent air leakage inward or outward. Air also leaks through porous brick. This can be prevented by a coating of sizing followed by one or two of whitewash.

Keep tubes and flues free from soot, and do not use scale-producing feed water. Both soot and scale reduce the efficiency of the boiler.

Keep blow-off and other valves packed, and repair leaky joints without delay.

Avoid blowing down of boilers and blowing of safety valves oftener than necessary.

DAILY BOILER ROOM RECORD.

....COMPANY. DATE..19......

Time.	TEMPERATURES.					Boiler Pressure.	Per cent. CO_2.	DRAFT (INS. WATER).				Feed Water Meter Readings.	Boilers Running.	Boilers Banked.	Remarks.
	Outdoors.	Water at Source.	Water entering Boilers.	Flue Gas.	Steam if Superheated.										

NOTE. — Time (first column) is arranged to fit each plant.

	First Watch	Second Watch	Third Watch
MEN ON DUTY	....	....	....
	....	....	....
	....	....	....
Coal burned (pounds)			
Ashes (pounds)			
Feed water (pounds)			
Tubes cleaned (number of boiler)			
Fires cleaned (number of boiler)			

NOTE. — This is to serve merely as a suggestion. Each plant requires a special form to fit local conditions.

Form No. 60D.

....................PUMPING STATION, ENGINEER'S HOURLY RECORD....................

Engine No......... {STARTED,......................} {REV.........................}
{STOPPED,......................} {GALS.........................} ....

Hour.	Counter.	Revolutions.	GAGES.					TEMPERATURES.			
			Heads.		Steam.		Vacuum.	Condenser Inlet.	Condenser. Outlet.	Heaters.	
			Force Main.	Suction Main.	At Throttle.	Receiver.	Condenser.				
			Feet.	Feet.	Lbs.	Lbs.	Ins.	Deg. F.	Deg. F.	Deg. F.	Deg. F.
7 A.M.											
8 A.M.											
9 "											
10 "											
11 "											
12 M.											
1 P.M.											
2 "											
3 "											
4 "											
5 "											
6 "											
7 "											
8 "											
9 "											
10 "											
11 "											
12 "											
1 A.M.											
2 "											
3 "											
4 "											
5 "											
6 "											
7 "											

CYLINDER OIL, GALS.................................
ENGINE " " ....
GREASE, LBS.......................................
WASTE, " ....

LIGHTING DYNAMO STARTED,..........................
DYNAMO STOPPED,...................................
AMPERES,..

Have all pipes containing steam or hot water properly covered to prevent radiation.

Return the condensation from heating system so as to raise the feed water to the highest possible temperature. Formerly engineers were reluctant to return to the boilers any condensation from exhaust steam of engines because the oil it contained was bad for the boilers. Practice is changing, however, due to desire for greater efficiency and improved devices for removing oil. Get good advice on this point. Oily drips are not returned, of course.

Employ the best firemen obtainable. This is the most important element in boiler-room economy.

It should be remembered that a large percentage of the heat of soft coal is contained in the volatile matters, that is, the gases. To save this heat from going up the chimney a method of firing must be adopted which will distill these gases, that is, drive them off as in a gas retort, and burn them before the fixed carbon in the solid coal is burned.

One way of doing this is by the so-called " coking " method of throwing the fresh coal upon the dead plate, and letting the gases be driven off and burned by the heat from the glowing coals at the rear. Later this charge is pushed back and a new lot takes its place. The difficulty with this is the liability of stirring up the fuel bed, which should be avoided.

Another way to get the same result is by the so-called " side firing " method of firing alternate fire doors, the gases from the fresh coal on one side of the grate being distilled and burned by the glowing coal on the other.

In any case it is essential to spread the coal in small quantities frequently rather than large lots at longer intervals. Keep the fuel bed even and not too thick (say six to ten inches).

Watch for thin spots and keep them filled, as a hole in the fuel bed allows an inrush of too much air.

Do not disturb the fuel bed too often.

Keep ash-pit doors open and regulate draft by dampers.

Do not let glowing coals accumulate in the ash pit, as they promote clinkering by keeping ashes on the grate too hot. As a further precaution against clinkering keep water in the ash pit if possible.

Draft equipment, whether natural or mechanical, should be sufficient to supply the required amount to support combustion. It is frequently found that extra boilers are added unnecessarily when a slight improvement of the draft conditions would have sufficed.

In the Engine Room.

Keep a record of engine, turbine, and generator performance, and power and pumping data.

Watch the atmospheric exhaust head for wasting steam. If it appears at regular intervals investigate the demands for power and see if the load can be reduced at such times.

Study the "auxiliaries," — feed pumps, blowers, circulating pumps, deep-well pumps, stoker engines, etc. These are usually very wasteful of steam, and can be allowed only in case their exhaust is all used all the time. If this is not the case, overhaul and repair them, or substitute motor drive where practicable.

On reciprocating steam engines take indicator cards often, reset valves, examine piston rings to avoid leakage of steam by the piston.

Examine the drip system for blowing traps.

Where there are no recording instruments, plot on cross-section paper a curve showing hourly changes of power load for a typical day once a month. Great losses are found at times of light load. Equalize the load, if possible.

In certain plants savings can be effected by turning low-pressure steam back into receivers for use in the low-pressure part of engines and turbines, to produce more power; in others, by the method of " bleeding " low-pressure steam from the receivers of compound engines or from the later stages of turbines. This steam, after generating some power, is discharged at a pressure slightly above atmospheric, and used for heating, the remaining steam going away through to the condenser. The best method for a particular plant can be determined only by a competent engineer after careful analysis of existing conditions.

It should here be pointed out, however, that the efficiency of any steam engine or turbine (except very large units) does not exceed 20 per cent. in a plant producing power only. But if the steam is first used for power and later for heat, the steam efficiency may approach 100 per cent. Hence see that the utmost use is made of exhaust instead of live steam in heating feed water and buildings, and for any other purpose requiring low-pressure steam.

In general, where buildings can be heated with exhaust steam, it is not economical to send steam from the engine to the condenser and use live steam for heating.

In the Heating of Rooms.

It is always right to use exhaust steam for heating buildings and water. Consequently, time should be taken this summer to modify existing plants in order that exhaust steam may be used. In doing this, straighten out the returns to avoid water pockets and give them a good pitch. No steam should be allowed to waste through the steam traps, which should be placed in locations where they can be seen at all times.

All windows and doors should be made and kept tight.

Install thermometers and a simple system of reports of temperature. In many rooms, the heat generated by friction of the machinery is sufficient to raise the temperature considerably, so that a regular system should be adopted of shutting off the heat soon after work is started, instead of opening windows. Except in rooms where special processes require a higher temperature, 65 degrees is adequate. Begin to standardize your room temperatures early in the fall. Do not wait and lower it suddenly when the colder weather comes.

In the Lighting System.

Shut off every unnecessary lamp and reduce size of lamps where possible without loss of good service.

Little more need be said on this subject, as attention has been called to the advisability of redistributing the lamps in accordance with the need. It is inexcusable to put a high-power lamp where a low-power lamp will answer, and no company is justified in permitting a bad system to continue.

Modify switching system to give better subdivision, so as to light only the parts of rooms being used.

Substitute tungsten lamps for carbon lamps.

BULLETIN NO. 3.

Bulletin No. 3 has been prepared by the operating engineers and firemen, copies of which are here for distribution.

SMALL SIZES OF ANTHRACITE COAL.

The Fuel Administrator desires that, where possible, anthracite screenings be used. This request is due to the fact that this coal can be shipped into New England easier than bituminous coal and not because of any other advantage in the use of screenings.

The thermal value of anthracite screenings varies from 9 000 to 13 000 B.t.u. per pound.

With a good natural draft, about twenty-five per cent. of this coal can be burned without affecting the boiler output. To burn a larger percentage, artificial draft is required, and grates with smaller air spaces will be required to prevent the sifting of the coal into ash pit. Screenings have been used successfully as high as eighty per cent.

RECORDS.

Referring to record of observation, "Weight of Feed Water Pumped," the pounds of water evaporated by each boiler should be kept for each watch or shift, as well as the total amount in pumping stations of considerable size.

This can be done by installing Bailey boiler meters on each boiler. These instruments indicate and record the output of steam from each boiler, also the rate of air supply to the furnace and condition of fuel bed, all three on the same chart.

Fuel and Power Committee — Organization Chart.

CHIEF ENGINEER.

Generation of Steam and Power.

Duty.

Make a list of power plant apparatus, stating general dimensions and commercial rating of boilers, engines, heaters, draft control, etc.

Systematize drawings of plant and piping systems, so that committee meetings may not be delayed for want of information. Add notes showing sewer connections, and every place where water or steam is thrown away.

Make list of meters, indicating and recording instruments, etc., now installed in station and others necessary.

CHAIRMAN OF WATER BOARD.

Chairman.

Duty.

Call monthly meetings and keep records of same.

Publish decisions of committee in their name on bulletin board in station and elsewhere, if desirable.

Compile records of savings made.

Approve recommendations for changes and appropriations.

Confer with chairmen of fuel and power committees in same town and with local fuel administrators.

SUPERINTENDENT.

Distribution.

Duty.

Systematic plans of distributing system.

Systematize records of users so that excessive use may be checked.

Call attention of committee to any seeming excessive use by any consumer.

If possible, check amount pumped with amount accounted for as used, in order to detect any large leakage in distributing system.

Committee of Registrators.

Coöperate with superintendent in keeping records and checking waste.

Begin daily boiler- and engine-room logs, if not already in use. Form depends on individual plant. See pages 238 and 239.

Report to committee every month the principal quantities, such as, daily coal burned, feed water pumped, evaporation (pounds of water per pound of coal), feed-water temperature, per cent. of ash, output, etc.

Report apparatus or repairs most needed to improve efficiency.

Organize subcommittee of firemen, preferably one from each watch.

Committee of Firemen.

Coöperate with chief engineer in finding and keeping up best method of firing.

Report general quality of each lot of coal as to moisture, clinkering, etc.

Report cracks in boiler setting, leaking valves, etc.

The chart will show which boiler produces the most steam, also which fireman produces the best results. It will show the fireman when the fire in the furnace is in the proper condition to produce the best combustion.

It is not possible to increase the apparent evaporation of the boiler by opening the blow-off valves, as only steam evaporated and passing out the boiler steam pipe is recorded.

Discussion.

The President. Mr. Main's paper is now open for discussion. There is one point I should like to speak of first, and that is the matter not only of the quality of the fuel but a continuation of the same kind of fuel. In our pumping stations we have been seriously handicapped recently from the fact that coal has come in from a comparatively limitless number of mines. One particular station might have coal from one district one week and from another district next week; or perhaps two or three districts at the same time. There is a great deal of difference, of course, in the firing methods which must be applied to get the best results from different qualities of fuel. A fireman will be accustomed to one method, and the Fuel Administration finds it necessary to send him coal, from another district, of a different characteristic. He no sooner gets accustomed to that than another kind of coal comes in and forestalls the condition of economy we are trying to attain. We had an illustration in Philadelphia of what we might call rivalry of emulation — the benefit which has come from that. We have one pumping station which is a fairly good one, and when the Fuel Administration sent out word that their engineering force was to investigate all the plants, to mark us up and grade us, and being supposed to tell us whether they could or couldn't do better, I thought I would forestall them and send them first to a plant which was a very good one, and keep them away from the others which I was more or less ashamed of. They adopted the suggestion and went to the best plant first, and gave us a rating of 96 out of a possible 100, which happened to be the highest of any plant in Pennsylvania. That had good results. When all the other pumping stations learned that that one station got a rating of 96, they all got busy and wanted to have 96. That shows the benefit of good-natured rivalry. Another point I want to touch on a little later is the labor situation, on which I wanted to air some of my troubles. Mr. Main suggested one of the most important things is a good fireman. We probably have all had the experience that no sooner do we get a good fireman nowadays than somebody else takes him at higher pay.

Mr. J. M. Diven.* In the discussion of this boiler-room practice, a man suggested that the fireman should be a higher class and higher paid man than the engineer. I have had good luck with firemen on the bonus plan, giving the crew that pumped the most water, or the same amount of water with a less consumption of coal, a bonus. This created a good-natured rivalry among the firemen. The results were excellent, and effected a considerable saving in coal all along the line.

Mr. Frank L. Fuller.† The coal we get for home use is certainly poor enough. It seems to me a pity to ship coal from Pennsylvania that absolutely will not burn. I do not quite understand why some action has not been taken in regard to it. It seems to me it is a decided waste to send coal that will not burn — it is only a waste of transportation charges to do so.

Mr. Diven. The reason for the poor quality of the coal has been explained to me by coal operators to be the impossibility of getting the pickers at the mines. They are substituting girls for the men who did the picking, and they have not done the work satisfactorily.

The President. We had some illustrations of poor coal that almost would not burn, and we were told not to unload it until some representative of the Fuel Administration came out and saw it, to see whether we would or would not pay for it. But we had to unload it, as it was all the coal there was. And finally when we put in the claim for rebate it seems that one of the patriotic coal miners had given up his coal-mining business and had gone into the Fuel Administration, and this particular coal came from his old mine, in which, I presume, he still had an interest. It was pretty hard to get a rebate on that coal.

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* Superintendent, Water Works, Troy, N. Y.

† Civil Engineer, Boston, Mass.

MR. DIVEN. You should have a B.t.u. contract.

THE PRESIDENT. All contracts have gone. Anything that is black goes nowadays. I had wanted to say one more thing: Mr. Main spoke about burning anthracite screenings. We are burning No. 3 Buck, so-called, and are trying to burn No. 4 Buck, but have not quite succeeded in that yet. No. 3 Buck is practically anthracite screenings. We are trying that on 12 500 h.p. and 8 350 h.p. boilers exclusively, with what we believe to be very admirable results. We have also been using that in some Murphy stokers with forced draft, and got very good results, using 60 per cent. soft coal and 40 per cent. screenings.

MR. GEORGE A. STACY.* I should like to say that I have coal enough to last until next spring. Last winter we did have some rather poor coal. If it had been in the summer when we were building roads it would have been a question whether we would burn it or sell it to the stone crusher for road building. I think we would have got better results on the road. But it was black, and we had to put it through. So that we did the same as the rest. But the last coal we had is very good. It is not as good as we used to get, but I am satisfied that we are very much favored if all the coal that comes to New England is as good as that which is coming to us at this time. It is free-burning and we get very good results. I think that the Fuel Administration now in Massachusetts is doing, as far as I can observe, all that they possibly can. If the other manufacturers and pumping stations are supplied as well, — and I hope they will be, — I think New England is to be congratulated. There may be some spots where they are not so well supplied but it would be impossible to be perfect in the matter. But I think they have endeavored, as far as I can observe, to supply the essential — what we call the real essential — plants, and of course the water-works man thinks we are all there is to it when you come down to talk about his engines. They can go without beer, they can shut down the breweries; but they can't shut down the water plants. So that I think we are all pleased that we are supplied as well as we are, in our state, in regard to the quantity and quality of the coal, at the present time.

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* Superintendent, Water Works, Marlboro, Mass.

Mr. John J. Moore.* I noticed that Mr. Davis put anthracite screenings with soft coal, — 60 per cent. soft coal. Out in the section beyond, the water works are using 100 per cent. of the same stuff he is using 40 per cent. of in his pumping station. Also, a factory at Auburn, Pa., is using nothing but that anthracite coal. It is coal that can be bought at a very low figure, and does the work fully as well as soft coal on a forced draft. There is no soft coal mixed with it at all; the same kind of coal that you are burning at 40–60.

The President. I do not think I made myself clear. We have 12 500 h.p. boilers and 8 350 h.p. boilers burning the anthracite No. 3 exclusively without any mixture. Then we have one other plant where we have 9 300 h.p. boilers with Murphy stokers, and in that one plant we are burning 40 per cent. screenings, because the stoker is not adapted to burn a complete anthracite mixture, though some Murphy stokers are burning that exclusively. But they have to have special grates to prevent the sifting of the fine material through. But with the Murphy stokers we have not been able to burn successfully over 40 per cent. But with the Cox stokers, of which we have 20, we are burning the No. 3 Buck alone without any mixing.

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* Owner and Manager of Water Companies, Boston, Mass.

EXPEDIENCY OF RAISING WATER RATES TO OFFSET INCREASED COSTS.

BY JOHN J. MOORE.*

[*September 12, 1918.*]

Hon. Skelton Williams, Controller of the Currency, in his report to Congress for 1917, goes into detail about the decline in earning capacity of public utility corporations. He speaks of the danger as a national one, in the loss in efficiency of such utilities due to lack of funds to operate plants efficiently on account of the increased cost of material and wages. Mr. Williams urges upon public utility companies and on commissioners in the state the necessity of some action to lessen the danger to war work and industries, many of which are dependent in one way or another upon the service rendered by public utilities.

In a general way, the cost of materials used in operating water plants has, as most of you know, advanced all the way from 150 to 250 per cent. Fuel and wages have advanced 100 per cent. Figures which I quote are taken from the records of companies in which I am interested and in all of which we have either increased or asked for an increase in the water rates.

First, I would call your attention to an item which can hardly be considered under either materials or wages, and yet which has added greatly to the operating expense of many companies. I refer to taxes.

In one Massachusetts company eight or nine years ago we were paying to the town in taxes 50 per cent. less than what we were receiving from them in hydrant rental. Last year we paid them $1 300 more in taxes than we received from them in hydrant rental; that is, the amount paid to them was 30 per cent. more than the amount received from them.

In another Massachusetts company the taxes have advanced 43 per cent. in the last five years.

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* Owner and Manager of Water Companies, Boston, Mass.

Operating costs in both of the above-mentioned companies have advanced during the last year in percentages varying from 50 to 80 per cent.

Where oil is used as fuel the increase is between 50 and 60 per cent. Where coal is used, the increase is about 80 per cent.

Wages of pumping stations have advanced from 30 to 45 per cent.

Wages of engineers have advanced 50 per cent. Day laborers have advanced 60 per cent. over 1917, which showed at least 30 or 40 per cent. advance over previous years.

Companies which two or three or even one year ago were earning an average of 8.8 per cent. on the capital stock are to-day earning 6.3 per cent. Companies which were earning, a year ago, an average of 4½ per cent. on the capital stock are to-day earning a little less than 2 per cent. on the capital stock.

Certain Maine water companies in which I am interested, and in which we have asked for an increase of rates, were built very shortly before the European war, and were unable to more than pay their operating costs. With the steadily mounting cost of labor and material, these companies are now unable to meet even the operating costs.

One of these Maine towns is a very good example of one of the reasons why a town or municipality should pay more for hydrant rental than has been customary in the past. The town is small and not compact, and many pipe lines are in streets where there are numbers of vacant lots. Now, these lots have increased in value since a water system was established in the town. The water company is obliged to pay for maintaining lines in the streets yet the company received not one cent of revenue from these lots.

This, in brief, is the problem many water companies are to-day facing. The question is, how to meet it. There seems to be only one way, and that is to raise the rates. Water companies are a necessity. The public must have water, and the companies cannot be expected to furnish it at a loss. Therefore there seems to be no question as to the necessity and wisdom of raising the rates to meet the increased cost. There is no other possible way to meet such cost unless it is to cut the dividends, and it is very rare to find a water company earning enough to pay any dividends which could be cut and give any adequate return to stockholders. In such companies as are able to meet the increased costs and pay their dividends, there would of course be no excuse for increased rates. In towns where the system is a gravity one — or where the town is so compact as to have made the original cost of construction small, and where in past years the company has been able to create a surplus, it may be possible for them to meet increased costs and still pay a reasonable return on their investment during lean years.

Practically all water systems were built in good faith, and people who invested money to construct them felt that such investment was a conservative one, probably knowing that the return would never be large but would at least always be sure. We cannot therefore expect such investors to sit by and allow the old rates to stand in companies where doing so would mean under present increased costs that dividends on the invested capital could not be paid.

Probably the greatest question is how and where to get the increased rates. I have mentioned before that there is a question now as to what proportion of rates the towns should bear as compared to that paid by domestic users. The old idea was that the town should get all it possibly could for the lowest rental. In the West it has been held by public utility commission that the cost of building and maintaining a system of water works giving fire protection to a town or city is about 66⅔ per cent. more than the cost of a system supplying water for domestic users only, and therefore the proportion of the burden of supporting a public utility in such a way as to render efficient service to the town or city should be greater for the town or city rather than for the domestic users.

In a recent decision given by the Maine Public Utility Commission it was stated that 25 per cent. of the total revenue necessary to operate a company and pay a fair return on the investment was not too large for the town to pay. (Guilford, Me.)

It is a much fairer adjustment of rates for towns and municipalities to bear the larger portion of the revenue required by water companies, but it becomes a matter of educating townspeople to this idea.

In a recent decision in Pennsylvania, the commission decided that a water company should be entitled to earn, in addition to the expense of operation and annual depreciation, a 7 per cent. return on the value of its plant. (York County Water Company.)

In another decision the same commission decided that a water company in a town where they ordered certain improvements should receive an 8 per cent. return on the valuation fixed by the commission. This valuation, by the way, was fixed by the commission as only fifteen thousand dollars less than the book value of the company. (Montrose, Pa.)

The California Commissioner also considers a net return of 8 per cent. on the valuation as a fair return. Taking an example a little nearer home, the Maine Utilities Commissioners have, in a decision rendered in 1917, stated that they consider 6 per cent. net income on the fair valuation of the properties of a water company a fair return on the investment. (Guilford.)

DISCUSSION.

[Remarks by Mr. Moore after finishing the reading of paper.]

MR. MOORE. I have had probably as much to do with these commissions as anybody that is here. I am interested in probably more water companies than any other one man. And I believe that instead of increasing the domestic rates to meet these increased expenses to which the companies have been put on account of the increased cost of fuel and labor, so as to pay the stockholders a fair return on their investment,— and water-company stock has been always considered all right, and held by estates and widows and orphans, — I believe that the towns and cities should pay a larger hydrant rental. In our state the towns pay a fair hydrant rental, but they get it all back in taxes, like the company that I referred to, which we are interested in. The company paid, last year, $1 300 more in taxes than they received for hydrant rental. Now, there is no question but what the company was the cause of a big growth in that town. When the company was installed, about seventeen years ago, the town had a valuation of about $3 000 000, while they now have a valuation of $12 000 000. At that time there were about 67 takers; now there are 1 200 to 1 400 water takers. The company asked the town to call a town meeting and increase the hydrant rental, which they refused to do, so the company has brought it before the commissioners to have them decide — which they have a right to do — whether the town shall pay a larger hydrant rental or the people shall pay a larger water rate.

In one of the towns in Maine where we had this same thing come up, we went to the town meeting and put it up to them in this same light, and they voted to increase the hydrant rental two hundred per cent. a year. I believe this is the fair way, because in all these towns there are miles of mains that are running by building lots that have more than doubled in value, and the owners are not paying anything at all for the use of the main. I believe that, by taxing those lots, and every other lot in the town in proportion, that is a fair way to get at the increased revenue that will have to be raised in order to give these water companies a fair return on their investments. I do not know of any of the water companies in this state (I am interested in three) that are earning more than a fair return on the amount of capital that is invested — none are earning over six per cent. — and I know of a number that are not paying any dividend at all, and never have earned money enough since they have been doing business to pay any. Since the increase in price of fuel and labor has occurred, on account of the war, some of the gentlemen who are interested in them tell me that they are not earning their operating expenses.

THE PRESIDENT. I should like to ask one question,— whether the hydrant rental in general is levied on each hydrant or whether there is any charge per mile of pipe or miles of mains that supply the hydrants.

MR. MOORE. It varies. Some communities pay so much a hydrant for each hydrant that is set, and some contracts with the towns say that a hydrant shall be set at intervals of 400, 500, or 600 ft. Some communities have made a contract for a certain sum for a certain number of hydrants, and all additional hydrants that are put in after that are free.

The company on which a hearing is to be held to-morrow made a contract originally with the town, back thirty-four or thirty-five years ago, that they should receive $1 200 a year for 30 hydrants, and all additional hydrants should be set and owned by the town at the cost to the town for the hydrant setting, but no rental. The company had a ten-year contract which ran out twenty-odd years ago, but are still going under that same rating. The town, to-day, has 206 hydrants for $1 200 a year, where if this company had got what they ought to get for hydrant rental, for the number of hydrants they have set, they would not have to increase their rates. So that the town is getting its water too cheaply, and somebody has to pay money enough to the company to give a return to pay their dividends. For that reason the company have increased the domestic rates 22 per cent.

The President. The reason I asked the question is that Mr. Moore mentioned the vacant lots, no property on them, no need of fire protection, but nevertheless of increased value, with an increased assessment and larger taxes because of the presence of water in the street. That situation seems to have been covered somewhat in rather a unique decision recently by the Pennsylvania Public Service Commission, which seemed to cover that very point when they made the charge to the town $7 a year, I think, on each hydrant, and $440 a year on each mile of pipe carrying a potential fire protection supply, which seemed to take care of the charges of the company in the area where there was a potential increase in the value of the property on account of the protection of the water.

Mr. Moore. There are some companies which on account of this war have had to increase their water supplies and spend a very large additional amount of money, to get water for the different factories that are working on war orders. I never believed in the sliding scale. I think the sliding scale is all right, but I think it slides the wrong way. I think a big user should pay more rather than less for his water. Instead of that, in most communities they start at a fixed rate. We will take, for instance, for a customer with a rate of 10 cents for the first 500 000 cu. ft., 8 cents for the next, and 7 cents for the next, and so on until the rate reaches 5 cents for all used in excess of a given amount. The extra cost of getting the water and laying large mains and putting in pumping stations and the extra amount of fuel is all caused by the big user of water, and the little fellow who has all the water that he wants has to pay for the additional cost that is occasioned by the large user. I believe the big user should pay. I *do not* think there should be any downward sliding scale in meter rates. [*Applause.*]

I can give you a very good illustration, as I have a large experience in the different states. We are now providing an additional supply for the town of Walpole. There is one mill out there that uses more water than the pumping plant will pump. We built the system for them twenty-four years ago; Mr. Coffin, one of our late members, was the engineer at the time; and that plant is just as good to-day as the day it was built, pumps and everything else are doing the work. This is a little community, a town of about 2 000 or 2 200 taps, I think, and they have an elegant water supply from driven wells. The pump is of a million gallons capacity and they are running it up to 1 400 000, — just as much as they can make it do, night and day. I was there yesterday and their gage showed the water 40 ft. below the bottom of the standpipe. That is pretty nearly an every-day occurrence. I tried to get them, about five years ago, to enlarge the plant; but they didn't take action until this year. They are now spending $150 000 for what we could have put in two years ago for $50 000 or $60 000. That is all for one mill, the Lewis Mill, that is making war supplies. I asked the chairman of the commission what rate was being charged. He answered, " About seven cents." I said, " You are supplying them too cheaply; you ought to raise their rates." He did raise their rate to 12 cents and they made the greatest holler you ever heard, yet they are making barrels of money out of war supplies. They have a 4-in. supply pipe under 85-lb. pressure and you can imagine how much they will take, running wide open. It takes all the pump delivers, but they said, " Why not put this extra cost on to the private takers? Let them stand a part of the burden." Now, their plant was all right before the Lewis Mills were connected and took this water away from them. Why should the private takers pay any more? The large user is the one that these companies have had to spend the excessive amounts of money for and who makes it necessary to lay larger mains and put in more pumps. The extra cost comes on account of the excessive user of water, and the large user is the one, in my estimation, who should pay, and the little fellow should not. I think the sliding scale is wrong there. It should be up instead of down.

In a recent hearing held before the Missouri Public Service Commission, the Commissioner held that in meter rates by water companies what is commonly called the " step rate " schedule is discriminatory. The statement of the commissioners " that the objectionable feature exists at the turning point where the consumer by increasing his consumption slightly is able to obtain a reduction in the total gross charge " is along the line I have just been speaking.

Mr. Frank L. Fuller.* I think Mr. Moore is about right on this question. Now, at Wellesley we have a good many greenhouses, and not so much lately but a few years ago they were very anxious to get a reduction in their rate. I always said, " Why should they pay less for their water than anybody else? There are plenty of poor people to whom the water rates are quite a hardship, who are getting no income from the water they are using, whereas the greenhouse men, to whom the water is a great necessity and from which they make a profit," — I don't know how good the greenhouse business is at the present time, — " why should they get their water at a less rate than anybody else, than the common person, the ordinary family? " We never made any change in their favor. I don't think we ought to. The people, as Mr. Moore has said, who are making money out of the use of the water certainly should not pay any less for it than those who use it as a necessity, in my opinion. And I think it is a point well taken.

Now, in regard to the price of water, I think some increase ordinarily ought to be made. I was talking, a few days ago, with a superintendent of water works, and he said, " A few years ago we dropped our rates so that they are very low, and we ought to increase them; but I suppose there would be a big kick if we did." But why should there? everything else is advancing. Now, at Wellesley we supply 16 000 gal. of water a year for $6. It is about the cheapest thing a man can buy. That is only 50 cents a month if he keeps within those limits. And what can he get for

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* Civil Engineer, Boston, Mass.

50 cents a month that is equal to that? Of course we also have a low price on electric lights; but electric lights and water are two great necessities of housekeeping and living, and I don't think we ought to feel as though we couldn't bear a little increase in this matter.

Mr. H. T. Gidley.* Is there any real reason why a manufacturer should pay less than the domestic consumer? It costs exactly as much to pump the water to him as it does to the small consumer. And in a good many cases the large consumers get their water for actually less than the cost of pumping, and the little fellow who pays the $10-a-year rate pays for the water the manufacturer uses. I can't see any justice in it at all. I think there should be a flat rate.

Mr. Moore. I agree to that. We sell the United States Government a lot of water in one of our plants, and they asked our superintendent for a low rate, — they wanted a sliding-scale rate. He brought it to me. I said, " We can do nothing except make the rate 35 cents for 750 gal., the same as to all other takers; we have to go out and spend a lot of money to see that they get this water; we were all right as we were; we have to spend a lot of money to give them the amount of water they want to use, and they must pay for it." I don't see why they should have water any cheaper than any of our individual users.

Mr. George E. Gormley.† I fully agree with what Mr. Moore says about the rates. In our case we have one large manufacturing plant which uses about 6 million cubic feet in a year, and we are supplying them with water at just half the price that we charge the domestic consumer. But of course the small manufacturer is in between. Two or three years ago we had two mains running into that plant, — one 4-in. and one 6-in. The 4-in. was the factory supply and the 6-in. supplied the hydrant system. They took a feed-pipe that supplied the boiler house off the hydrant system, — a very poor plan. That was put in quite a number of years ago. We imagined that there was some water going into that plant that was not accounted for by the two meters in use. So I installed a 6-in. detector meter in the street, that measured all the water that went into the plant, and the first month there was 4 500 cu. ft. that our meters had not accounted for. I do not know how long they had taken that quantity, but it made quite a difference.

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* Superintendent, Fairhaven, Mass., Water Co.

† Water Commissioner, Abington, Mass.

Mr. Hugh McLean.* It gave me pleasure to hear the gentleman express himself in that way. Twelve or fourteen years ago, when we used to express our feelings about the rates, I contended that it was a burden supplying the larger customer. In my city of Holyoke we had three rates, — 15 cents, 10 cents, and 5 cents. We undertook to abolish the three rates and tried the experiment first of abolishing the 15-cent rate. We went along a year or so with the 5-cent and the 10-cent rates, and we met a lot of opposition from the owners of private water plants who claimed that it would be a loss to them, that their large consumers would withdraw from using their water and it would mean a benefit for the private concern. We eventually abolished all the rates in Holyoke, and we have one flat rate. Instead of having 5 cents, 10 cents, 15 cents, we raised the rate from 5 cents to 5⅔, with a discount which makes 5.1. We have had no trouble since, and we get them just the same. If we have to raise the rates now I believe we should raise them to the large consumer and leave the rate of the small consumer as it is. I think the reason those rates were established on those bases some twenty-five or thirty years ago, when the works were built, was that the large mill owner of the town was one of the members of the water department and the rates were made in his interest. And it has continued to be so. But why should it be so? In dealing with the United States Government, if anybody wants to buy a million dollars' worth of postage stamps he has to pay for them at the same rate as the man who only buys one. Some years ago, when the trust problem confronted us, in the beginning of the trust era, we had a great many mills. Those mills had the three rates of 15, 10, and 5. But they combined, and then they said, " We will only pay one rate." And they obtained the lower rate and have held that, consequently resulting in a loss to us of about $3 000 a year water rates by their consolidation. We were able to meet them, on the other hand, by abolishing all these rates and making them pay the flat rate. I have always contended that the large consumer was a burden to the water department rather than a benefit.

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* Water Commissioner, Holyoke, Mass.

MR. CHARLES W. SHERMAN.* I do not want to take up the discussion of the sliding scale just now, but the point that Mr. McLean has just raised brings to my mind that Holyoke is the only place I have ever heard of where the water department of the municipality, or the water company, has admitted that the consolidation of companies ever made any less consumers. I think, so far as that particular thing is concerned, that they were rather "easy" in getting into that condition.

I was very much interested in Mr. Moore's data about the increase in taxes on water companies, and I hope before the paper is published he will be able to compile data from his several companies and give us something in figures as to the fluctuations and change in those rates. I have followed the figures of water companies that have come to my knowledge with a good deal of care for a number of years, and there is an unmistakable tendency for increased taxation of water companies. That may be equitable and right — I think in many cases it has been so, as in former years they were under-taxed. But I am sure that some are over-taxed at the present time. The range of taxes, as far as my observation goes, has been something between five and twenty-three per cent. of the gross revenue of the companies. If you take twenty-three per cent. of the gross revenue of the company for taxes it does not leave a great deal for depreciation and interest. And if that much is going to be taken in taxes, the company must be allowed to gain sufficiently in the rate to make it up. It can be assessed, I presume, to the extent of all the available revenue of the company. On the other hand, when you come to the five or six per cent. of the gross revenue, paid for taxes, which I think is the case in a few companies, it probably is less than a fair share of the taxable burden of the community.

The matter of hydrant rental for fire protection for municipalities is a most inequitable one in a very large number of cases. Of course it is known to all water-works men that a considerable portion of the cost of a water system is due to fire protection. In the very large cities it may be as low as 10 per cent.; and in the small ones, as much as 66 per cent. or more. The hydrant rates have usually been established without any reference to the actual cost, and in comparatively few cases has there been a systematic, scientific attempt to work out rates which are equitable and fair.

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* Civil Engineer, Boston Mass.; Water Commissioner, Belmont, Mass.

MR. J. M. DIVEN.* It is a little out of the line of discussion, but I should like to ask the gentleman from Holyoke if he dropped all his large consumers if he would not have to raise his rates to the small consumers.

MR. McLEAN. No, we would not; because we have to provide a pumping station principally for them. They use so much of the water we have to build new reservoirs and larger mains to satisfy their large consumption. And they obtain a smaller rate, or less than what the rest of the consumers are paying. If they are only paying 5 cents and are using a million gallons a day, and the rest of the community is paying 15 cents and is using a half million a day, it would be a help to get rid of the large consumer. You would not have to supply the pumping station or reservoir.

MR. FULLER. We formerly, at Wellesley, supplied Wellesley College with water. They thought they could get it cheaper by putting in their own supply, which they did, and we were very glad they did it. I have never been able to find out just what it costs them now, but it seems to me it must be costing them as much as we were charging. But we knew we were supplying them at less than it really cost us to furnish the water, taking into account the cost of the works, depreciation, and so forth. Perhaps we ought not to have taken any depreciation into account, but I think, even without taking into account the matter of depreciation, that we were not getting for the water as much as it cost us, and we were very glad that they obtained their own supply. And I think that is the feeling, perhaps, of a good many water-works systems, — that these increases in the supply are not profitable. Some people think that when you once have a water-works plant established you should not, perhaps, charge anything for more water; that, while it takes a little more coal, it does not take any more engineering force, and all those things. But the proper way to consider the matter is to divide the number of gallons that you supply by what it costs to supply that water, which I do not think is always taken into account.

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* Superintendent, Water Works, Troy, N. Y.

Mr. McLean. Hydrants are quite often extended on land whose owner pays no water tax; hence, the water user should not be asked to pay more for his water on account of that situation. If it is extended a half mile or a mile, I think it is just to tax the owner of that land a dollar a foot for the extension, and tax the city for every hydrant that is put on the extension. We tax the city $8 per hydrant a year, and for every hydrant we put on an extension we tax the petitioners a dollar a foot, which I think is a just way. There is no reason why the extension of those hydrants ought to be added to the consumers' expenses for water.

Mr. Moore. That is true. You take a number of those lines where the works are owned in some places by the town and in other places by the company — and there are a great many miles of pipe that are laid and hydrants put on mains that are laid by tracts of vacant land. We have one case now where they have asked us to lay three miles of pipe to get to about a dozen houses. And in order to get us to lay that line, they agreed to take hydrants on the line, along a street where there is not a house within a mile, set them in every 500 ft. to put out any stone wall that might get afire, and pay $33.33 a hydrant, in order to get water up to those dozen houses. Of course we refused to go up there, because we couldn't get the money. But in that particular case they are proposing laying a number of miles by vacant land on both sides of the street that is going to be increased in value by the pipe line going by. When a pipe line runs by a house lot, that lot is worth more because they can get the water, and I believe that land should pay a higher tax. If that land is worth $500 an acre without the water, it should at least be doubled up and taxed for $1 000 an acre. But they do not do it in this particular case, but the rest of the community would have to bear the burden that the selectmen were going to put on them by running this pipe line up to take care of, I think, eight or ten houses at an expense of about $30 000.

Mr. Diven. That is a speculation on the part of some land company.

Mr. Moore. That was a speculation on the part of the town. The company did not want to do it.

Mr. Diven. But the owners of that land were the beneficiaries.

Mr. Moore. They would be the beneficiaries.

Mr. Diven. My practice has been to let them pay for it, and then when they develop and there is business there to pay, take the line over and pay them for it. But until it does develop let them stand the entire cost. If the development does not amount to anything, they are out; the city is not. I do not see why the city should spend money to help along land speculation.

Mr. Moore. Well, that is true as far as the city is concerned, but in this particular case the city is not spending any large amount of money at any one time, but it is creating a tax on that city when they pay this hydrant rental, which they probably will never get any return on. We have all kinds of conditions in different communities; no two communities are alike.

Mr. Henry A. Symonds.* What is the attitude of the Public Utility Commissions and the general public towards meeting the question of increased rates?

Mr. Moore. That differs in different communities. As I said, in one town where we had to increase the rates I went there to a specially called town meeting and told my little story to them. I was asked by some of the leading men in the town what I thought was the proper and just way to get at it, and I told them that I thought — not because I was interested one way or the other — that the better way for them to do was to increase their hydrant rental and to put the whole burden on the town, and to leave their water rates as they were. The biggest taxpayer in that particular town was a big mill that paid better than half of the taxes paid in the town. They did not use any of the town water as they had their own water supply, but they had the benefit of this water system which was put in because it protected all of that property in the town; if the town was without a water works and it burned down, the mill would not have any homes for its help. They thought that was correct, and voted to increase the hydrant rental 200 per cent. That took care of that particular Maine town.

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* Civil Engineer, Boston, Mass.

In a Massachusetts town we had a meeting called by the selectmen, and told them our story and the amount of money we would have to have in order to meet the extra expenses occasioned by the war, on account of our fuel, raising the help, and everything of that sort, and to continue paying the dividend of five per cent. We then asked them to appoint a committee, have them go to our office and take our books and go over them from the day the company was organized and see whether we were entitled to what we asked for, and if we were not we would throw up our hands, but if we were we wanted it. That committee was appointed by the chair, and went over the books in that particular town, taking about a month or six weeks in doing it, and when they got through I asked them how they came out. They said, "The only way we can figure it, you do not ask enough. [We asked a 33 per cent. raise.] We will leave the hydrant rental as it is, and let the consumers pay the difference"; which they did.

In another town I tried to do the same thing, and asked them to give us a hearing, but they would not do anything. They flew up in the air and said we were getting too much revenue anyway, and on account of my owning so many companies I had been paying myself a salary of $25 000 or $30 000 a year, and that was where all this money was going to. But, as it turns out, I am free to say that from all the companies I am president of or manage I do not receive one cent of salary. I do own a big block of the stock, and I get my dividends the same as in everything else, and I propose to charge rates enough to get it, too. But they would not give us a hearing, so that that is before the commission. It has not come up yet.

In another town I am interested in, we went to them and told them that we thought they ought to increase the hydrant rental to take care of a deficiency that we were going up against, and if we did not get additional revenue we would have to cut our dividend out altogether. They would not increase the hydrant rental, would not do anything with us, and we increased the rates 22 per cent. Then they employed what they figured to be the best talent in the state in the way of engineers and lawyers, and are coming before the commission to have the rates reduced, and that hearing comes up to-morrow morning at ten o'clock. But I am free to say now that the rates will not be reduced. The tendency has been of the commissions, in all the different states that I am interested in — and I have been before the commissions in all of them on a number of different occasions — to give the company a fair return on the capital invested. Their idea of a fair return runs all the way from 6 to 8 per cent. In Massachusetts, the commissioners think that the companies should earn 8 per cent.; Maine says not less than 6; New Hampshire says 7 or 8. Those happen to be the three states that I have plants in at the present time, although we have a number in the West Indies. The attitude of the commissions seems to be to give the company a fair return on its investment. The Maine commission has gone so far as to say that officers of the companies — that is, the presidents and treasurers — should charge salaries. They never have, in any of the companies I am interested in. When we go there, we simply charge our expenses to and from the plant. And we have not any companies that pay over 8 per cent., but have some that are down as low as 4. We propose to make them all pay something, — pay their way and pay a dividend.

MR. SAMUEL A. AGNEW.* I find one of the greatest difficulties I have, in the town where I am, is to educate the people to the thought that the town does not own the water works. Now, it is a strange thing, but as a matter of fact the ordinary consumer knows absolutely nothing about what the works are or who the company consist of, except there is a faucet that they get water out of, and if it becomes yellow or dirty they kick.

Another great difficulty we have, even with the intelligent, is to show them the difference between a municipally owned works and a privately owned works. And they compare, for instance, our town, which is a small town, with Brookline or Belmont, or such places as that. They say, " We get our water for $8 a year, and have so many bathtubs or water-closets, and it costs me $6 or $8, while you people want to charge $40." They do not take into consideration the fact that they have a town to fall back on if the water department does not pay. We have no town to fall back on or to get an appropriation from to help us out. Now, if there were a way to get at the people and educate them to the fact that we are simply a corporation or a concern that is out to do business and to sell our goods at a profit, we could help the matter a great deal; but that is a tremendously difficult thing to do. Now, this summer I have had a great deal to do, and I have hardly talked with an individual but that, after I got through with him, has seen the justice of our demand, of our asking the advanced rate. The difficulty is to get the town as a whole to see it. One or two men, or a dozen men, can't go around and act as missionaries for a water company and convince all the people of the town of the need of the advance. Now, if there was some way we could get at it and show them that here we are, an ordinary corporation, out to get a fair return on the investment, we could do a great deal better. Otherwise we are up against it and have to depend on the commissions to lay down the law and say that the people have to pay us so much money to keep the thing going.

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* Superintendent, Water Works, Scituate, Mass.

Mr. Moore. I want to say another thing which you may know about. In the past year there have been a little above 500 applications from public utilities in New England, asking the Public Utility Commissioners to increase their rates — other companies as well as water companies; 487 out of 500 were granted.

The President. At the rate asked for?

Mr. Moore. Either that or some rate; 487 out of the 500 got an increase. So that that shows how the public utility commissions look at this thing.

Mr. Fuller. Those were private companies?

Mr. Moore. Yes. And we have had this same thing right out here, as you people know, in our street railroads. This is getting a little off from the subject, but in all of our communities we built street railways fifteen, twenty, or twenty-five years ago, and when they were first built they were all paying a fair return on the investment to the stockholders. Most every one of them paid a little dividend to start with. Then the price of labor and materials went up; but the fare was still 5 cents. That did not go up. Everything else doubled; until finally they couldn't even buy their rails and ties, or keep their cars or power houses in repair, and some of them did not even get money enough to buy their fuel.

Now, if our public utility commissions had had backbone enough at that time, had not been playing politics too much, and had allowed these roads to increase their fares to 6, 7, 8, or 10 cents, which is little enough to ride on any of those lines, we would have had a different proposition on our street railways to-day than we have. Here is our Boston Elevated, which you all know. The state would not let them increase their rates. They appointed trustees who increased the fare to 7 cents. Now the trustees propose a second increase to 9 cents. They ought not to stop at 9 cents; they ought to make it 10 cents, and then they should give them zones to ride in for 10 cents and not let them ride all over and around Robin Hood's barn. I can get on a car at Arlington, connect with the Elevated, go to Forest Hills, then take a surface car at Forest Hills and go clear to the Boston line, pretty nearly to Dedham, for 7 cents. That is not right. It is just the same with the water company. Everything with them has increased in the last eight or ten years, particularly in the last three years since the war has been going on. One street railway in particular I put $28 000 into when built, — of good, clean, hard cash, — because I thought we ought to have a road in the community. It paid me a dividend for five or six years; but that stock to-day is not worth the paper it is written on. Is there any reason why it should not be worth as much now as it was twenty-five years ago? Not a reason in the world. The community is getting the benefit of my money, and it should pay rates enough to give a return on my investment. It is just the same with the water companies.

Mr. Frederic I. Winslow.* The argument presented by Mr. Moore that the large consumer should pay more rather than less than the smaller consumer per gallon for water appears to have stirred a responsive chord in the minds of the members present, and all the remarks seemed to agree with his point of view. In presenting the opposite side of the case, the writer does not do so from a conviction of its soundness so much as from a feeling that the question may have two sides.

The chief argument has hitherto been the wholesale *versus* retail argument; that is, that in all lines of trade the large order receives the benefit of a lower price, and that in the sale of water this rule should be observed. In very few cases, however, is this rule observed in water-works practice where the wholesale consumer has his buildings widely scattered, but only where the water is all taken from one large tap.

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* Consulting Engineer, Boston, Mass.

The extra amount pumped in such cases can hardly cost any less per gallon for the large amount than for the smaller. Where the supply is wholly gravity, the cost would not vary at all. As the mains have to be somewhat larger, on the whole, to accommodate the large consumer, there would, it seems, appear to be some argument for charging him more.

The only reason for charging him less equitably would be in the case — and this case occurs very frequently in large communities — where a large consumer is between or near smaller ones or in any location where it requires very little main pipe to surround his property or to pipe it for his necessities. In this case it is frequently the case that a few hundred feet of pipe are laid for a heavy consumer while at the same time the municipality will lay a much greater length for a very much smaller revenue. It is probably for this reason, coupled with the general wholesale price principle, which has brought about the discrimination in rates.

REPORT OF THE COMMITTEE TO INVESTIGATE CONDITIONS IN WATER-DISTRIBUTION SYSTEMS ARISING FROM THE SEVERE COLD OF WINTER OF 1917–18.

[*September 11, 1918.*]

MEMBERS OF THE
NEW ENGLAND WATER WORKS ASSOCIATION:

Gentlemen, — The Committee to Investigate Conditions in Water-Distribution Systems Arising from the Severe Cold of Winter of 1917–18 respectfully submits the following report.

Two hundred and thirteen questionnaires, similar to the form appended, were sent out, and ninety-five replies were received.

The results of our investigations and answers to questionnaire have been summarized in detail in the appended table.

Very few of the active superintendents and managers of to-day have ever experienced such a condition as prevailed from about the middle of November, 1917, until the middle of March, 1918, nor are there many of the New England superintendents who could reply to the questionnaire as did one man in Maine. He reported no services frozen, no main pipes frozen, and to the questions on temperature and frost penetration could give no answer, as he had been in Florida all winter.

Some of us wished we were in Florida, but thought we were in a place reported to be even warmer. Sherman's well-known definition of war had nothing on what the life of a water-works superintendent was last winter.

Unusually long stretches of extremely cold weather and an absence of snow made ideal conditions for the penetration of frost.

The following data, compiled from the records of the United States Weather Bureau in Boston, Mass., clearly show the unusual character of the weather the past winter.

	Degree.
The average mean temperature for last December, January and February was	24.
The average normal temperature for the same months for the past 48 years was	28.9

The six coldest years, considering the months of December, January, and February only, and excluding 1917–18, for the past forty-eight years, were as follows:

		Degree.
1874–75	Average mean temperature for Dec., Jan., and Feb.	24.3
1872–73	Average mean temperature for Dec., Jan., and Feb.	24.7
1903–04	Average mean temperature for Dec., Jan., and Feb.	24.7
1904–05	Average mean temperature for Dec., Jan., and Feb.	24.7
1880–81	Average mean temperature for Dec., Jan., and Feb.	25.4
1892–93	Average mean temperature for Dec., Jan., and Feb.	26.

The following further temperature data, compiled from the records of the United States Weather Bureau at Post Office Building, Boston, Mass., is presented:

	Nov.	Dec.	Jan.	Feb.	Mar.
Highest for month, 1917–18	65	48	54	57	69
Lowest for month, 1917–18	13	−14	−3	−10	11
Mean for month, 1917–18	39	23.7	21	27	37
Highest in 48 years	76	69	70	64	78
Lowest in 48 years	−2*	−14	−13†	−11‡	−8§
Average daily excess or deficiency, 1917–18, compared with normal for 48 years	−1.8	−7.9	−6	−1.1	+1.7
Accumulated monthly excess or deficiency, 1917–18, compared with normal for 48 years	−54	−245	−184	−27	+54

	1917.		1918.		
	Nov.	Dec.	Jan.	Feb.	Mar.
Snowfall in inches, 1917–18	2.2	7.	13.8	5.7	12.8
Snow on ground end of month, '17–'18,	Trace	.3	4.6	Trace	None

The snowfall was light. In November it was negligible; in December there were eight snowfalls of less than 0.9 inches and one of 3.7 inches, immediately followed by rain; in January there were six snowfalls of less than 0.8 inches, one of 3.2 inches, immediately followed by rain, one of 3.0 inches, two of 2.0 inches, and one of 1.1 inches; in February there were four snowfalls of less than 0.8 inches, one of 1.8 inches, one of 1.2 inches, and one of 1.0 inch.

Depths to which main pipes and services were laid seemed to make little difference, for in the localities where pipes were laid according to the average frost penetration of previous years, the frost went just a little deeper this year. In fact, the frost was no respecter of places or persons, as a questionnaire missent to Canton, Miss., came back with the information that the minimum temperature was 10 degrees above zero, and that there was one inch of snow upon the ground. Our good friend John H. Walsh, of East Hartford, Conn., reported that he had 625 frozen services, affecting 785 families, rich and poor alike.

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* 1875. † 1882. ‡ 1896–1914. § 1872.

Aside from the inconvenience and danger of sickness through lack of sanitary arrangements caused by frozen services, frozen hydrants were the cause of much worry and a great amount of labor to the man in charge, and of danger to the community. Not only did they freeze, due to slight leaks on the valves and the entrance of ground water through the drips, but in some soils they were raised by the action of the frost on the ground so that they were severed from the lateral. Many more cases have been reported of hydrants broken off above the valve, the break not being discovered until the hydrant was used, or upon inspection during the spring and summer. It is probable that much more hydrant trouble has occurred than has been reported, owing to the lack of regular inspection of hydrants by the smaller towns.

The meter companies ought to be able to declare extra dividends this year, for everybody seems to have been hard hit by frozen meters. From a study of the summary it would seem that it made no difference whether a meter was set in the cellar or in a box outside, although, if an explanation from places showing a small percentage of outside meters frozen could be had, it might appear that those meters which were set at the depth of the service in a well-constructed vault were the ones to escape injury.

The methods used to thaw mains and services were many and varied, from the pick, shovel, and teakettle, as illustrated by a member from one of our Massachusetts islands, to the "natural" method used by a neighbor on an adjacent island. We are of the opinion, after scanning the bills for thawing, that this latter method is by far the simplest and most economical, provided you can get your consumer to agree to wait for these natural results.

Hot water and steam were used in many cases, but they are manifestly not best suited for conditions which prevailed during the past winter.

The calls for help that went out from the water-works fraternity to their brethren of the electrical fraternity resulted in the development of many types of electrical thawing apparatus.

The one best known and most generally used was through the overhead wires of the lighting companies. In this type the high-tension primary wires, carrying 2 200 to 2 400 volts, were tapped and the current carried to cut-out boxes with suitable fuse wires. From the fuse boxes the wire ran to one or more transformers whose capacities ranged from 15 kw. to 75 kw.

In the large majority of cases the voltage was reduced by the transformers to 110, and the amount of current delivered upon the pipe was further controlled by the use of a water rheostat.

The motor-generator set was used to a considerable extent.

One outfit consisted of a 25-volt, 250-ampere, direct-current generator, equipped with a volt-meter, an ammeter and an automatic circuit breaker, mounted on a Ford truck. On the truck was also mounted a countershaft carrying a sprocket wheel at each end, and a driving pulley which was connected to the generator by means of a leather belt. On each side of the jackshaft of the truck was attached a new sprocket wheel just outside of the existing driving sprockets. Upon arrival at the point where the work was to be done, the chains were taken off the driving sprockets and attached to the new sprockets at the jackshaft and to those on the countershaft mounted on the truck. The Ford engine was thus utilized to generate the required current.

The storage battery was used to a limited extent.

One outfit consisted of three trays, each containing eight 2-volt cells, so connected up that a voltage of 16, 32, or 48 could be obtained. Another of six trays of four 2-volt cells each was still more flexible, as voltages of 8, 16, 24, 30, 36, and 42 were possible.

Another of six trays of three 2-volt cells was connected in multiple series, giving a voltage of 35. This outfit proved unsatisfactory, as serious damage was done to the pipes in a number of cases.

The properly connected storage battery has proved very efficient. Like the motor-generator set, it is flexible and portable, and, when operated by an experienced man, it is a safe method. If improperly used, damage to the pipes and to the battery itself can easily result.

The batteries must be recharged after a continuous day's use, the operation taking eight hours' time.

The storage battery is delicately constructed, and can be easily damaged, both in discharging and in recharging. It deteriorates when not in use, especially during the long period of the year when it is not needed.

To reduce the probability of damage to a minimum, an experienced man should be in charge of the work, instruments to determine both voltage and amperage should be used, reasonable time should be taken for the actual work of thawing, and under no conditions should a larger current be used than experience has shown to be reasonable under similar conditions.

While available data are to some extent conflicting, and more exact information is desirable, yet general experience shows that, for the work of thawing ⅝-in. lead or ¾-in. iron service pipes of average length, using 4/0 wire for leads, and with good connections, the following data may be considered as approximately normal:

Drop in pipe	14 to 18 volts.
Total voltage required	20 to 30 volts.
Amperes required	175 to 225 volts.
Time required to thaw	6 minutes, plus or minus.

With larger pipes, or with pipes longer than the average, of course more electrical energy and time is required.

For all-round, efficient, economical work, your committee looks most favorably upon the motor-generator set. It is flexible, can go where the work is to be done, can work continuously, does not deteriorate when not in use, can be made almost fool-proof, and, if properly designed, is the safest type of apparatus from the point of view of danger to the water pipes.

FRANK J. GIFFORD,
THOMAS E. LALLY,
DAVID A. HEFFERNAN,
F. A. McINNES,
Committee.

NEW ENGLAND WATER WORKS ASSOCIATION.

COMMITTEE TO INVESTIGATE CONDITIONS IN WATER-DISTRIBUTION SYSTEMS ARISING FROM SEVERE COLD OF WINTER OF 1917–18.

FRANK J. GIFFORD, Supt. Water Company, Dedham, Mass.	THOMAS E. LALLY, Assistant Engineer, Water Service, Boston, Mass.
FRANK A. McINNES, Division Engineer, Sewer and Water Service, Boston, Mass.	DAVID A. HEFFERNAN, Supt. Water Works, Milton, Mass.

The Committee is called upon to make its report at the September meeting of the Association and *it is essential that return be made before June 1, next. Please fill out this blank and return it to Frank J. Gifford, Superintendent Water Company, Dedham, Mass.*

Name of city or town. *Date*
Municipally or privately owned.
Number of services in use.
Number of services frozen.
Depths to which services are laid.
Material used for services.
Miles of main pipe in use.
Lengths and sizes of main pipe frozen.
How many of frozen mains were dead ends?
Depths to which mains are laid.
Material used for mains.
Number of hydrants in use.
Number of hydrants frozen.
Number of hydrant connections frozen where main was not frozen.
Number of inside meters in use.
Number of inside meters frozen.
Number of outside meters in use.
Number of outside meters frozen.
Is the supply from springs, wells, or from surface sources?
What was the average temperature of the water at source of supply?
What was the minimum temperature of the water at source of supply?
What was the minimum temperature of water in the distribution system?
Give, if possible, maximum, minimum and average temperature of air monthly from November 1, 1917, to April 1, 1918.
Character of soil where frost penetration was greatest.
Greatest depth to which frost penetrated.
Average depth to which frost penetrated.
Average depth of snow on ground.

PLATE I.
N. E. W. W. ASSOCIATION.
VOL. XXXII.
COMMITTEE ON
DISTRIBUTION SYSTEMS.

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What methods were employed in thawing services?

What methods were employed in thawing mains?

Average cost per service of thawing by different methods employed.

Will owner, occupant or municipality pay cost of thawing services?

Will owner, occupant or municipality pay cost of meter repairs?

Does consumer or municipality own meter?

What allowance was made to consumer for water wasted through meter to prevent freezing?

If meter was out for any considerable time will any charge be made for water during this period?

State on what basis estimate will be made.

Please furnish detailed description, sketch, and photo, if available, of thawing apparatus used, however simple it may have been.

Your committee is ambitious to make this report as helpful as possible to the other fellow.

Name of person furnishing information.

Official position.

Address.

DISCUSSION.

MR. F. A. MCINNES.[*] As one member of the committee, I should like to say that what most impressed me was the necessity of getting all the knowledge which was available, all the knowledge we could get, as to how we could thaw without doing damage, for it seemed to me that more damage has been done in the past than we fully realize. Along that particular line I should like to hear a lot of discussion.

We made a very successful use of the storage battery last winter after we had discovered that it was a dangerous tool to work with unless it was intelligently operated. By dividing our battery — we had 24 cells — into three trays of 8 cells each, with the multiple of a possible voltage of 16 cells in each unit, we were very successful. But our first attempts, when some of our men, without stopping to think what the result would be, went ahead with the full 24 cells in series, were disastrous. Our work was arranged so that we carried it on twenty-four hours a day, as nearly as we could, taking eight hours out of each twenty-four for recharging a battery. As far as I have been able to determine the depreciation of a battery during the winter's service, it was about one-third, that is, about 30 per cent., which is not serious. What will happen after it lies idle all summer and then has again to be put in condition is another matter. But the actual operation of the storage battery properly regulated was entirely satisfactory, although personally I am not convinced that it is not too complicated a piece of machinery for general purposes.

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[*] Division Engineer, Sewer and Water Service, Boston, Mass.

Mr. J. M. Diven.* How did the cost compare with other methods?

Mr. McInnes. It was cheaper than the others. Buying the storage battery outright and doing the work with our own men, it was very cheap.

Mr. Diven. Does that include the depreciation?

Mr. McInnes. Yes. It was the cheapest method we used. We didn't use a generator set.

Mr. Caleb M. Saville.† We had between six and seven hundred services frozen at Hartford, and about half of them we thawed by electricity, using a storage battery, and about half of them by the steam method. So far as the cost was concerned there seemed to be little difference. One of the objections Mr. McInnes has spoken of, that is, the deterioration of the batteries during the summer, we overcome in a way, because the street-cleaning department in Hartford uses storage batteries, and the street-sweeping machines, of course, are not used during the winter time. We were very fortunate in being able to take the batteries from the machines — there happened to be five of them — and put them on our own platform trucks and take them around where we wanted to. So in our case it was quite an economical way of doing.

Mr. Frank L. Fuller.‡ I should like to ask Mr. McInnes how long it takes to charge these batteries after they have been used, and whether he didn't have to have several of them in order to provide for that.

Mr. McInnes. The time of charging was eight hours. There again intelligence is needed, for the charging must be properly done. The batteries can be destroyed by improper charging as well as by improper discharging.

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* Superintendent Water Works, Troy, N. Y.

† Superintendent Water Works, Hartford, Conn.

‡ Civil Engineer, Boston, Mass.

MR. GEORGE F. MERRILL.* The conditions vary considerably throughout New England. In Greenfield we have from four to six feet of snow when in other places they have very little snow. Our trouble with frozen pipes is confined very largely to the services; we have very few leaks that occur in the streets. I hardly agree with the committee's decision on the electrical apparatus for thawing. I believe the light, portable thawing machine that uses hot water, where you only have to thaw a service a short distance, is much more economical and quicker than the electrical. Of course if you have a long distance to thaw and there are a great many of your services frozen in a certain locality, you can make electrical connections quicker and can save time; but if they are isolated services, perhaps a half mile apart, the small, portable machine will give you much quicker results and will be more economical.

MR. DIVEN. Mr. Davis thinks all trouble centers in Troy; I think so myself sometimes. The cold weather performed another service for us there and gave a very good argument against laying laterals to the curb when the streets were to be paved. Thousands of them froze. The frost penetrated to an average depth of about 5½ ft. The number that froze was innumerable, — from 50 to 100. Everywhere those sub-laterals froze and burst. Their utility is perhaps rather doubtful. Usually when the house is built the lateral is not in the right place and another service is required. Of course the object is to save tearing up the pavement, but it doesn't save it in this case.

MR. GIFFORD. I want to say to Mr. Merrill that the committee did not take any one locality into consideration in recommending electricity over hot water. But for the conditions that prevailed last winter in general throughout New England the electrical power was considered best.

MR. THOMAS E. LALLY.† I should like to say a few words about thawing by electricity. I was detailed last winter by Mr. McInnes to follow the electric machines, and we have had four or five batteries, and I think,at one time, seven overhead feed machines out. I did not follow each one every day, but I went around from one to another. And I remember going one day to Fulton Street and picking up a machine that was thawing by direct current through the mains in the city proper. It was raining very hard and the man in the manhole was kicking because of the short circuits that he got off the cable. It brought up the discussion whether we would stop or not. I told him I thought if he used due care he could get along. " Well," he said, " we had some trouble last night down on Cambridge Street. About eight o'clock we had a frozen service at a barber shop, and we hooked up to the manhole and the pipe inside. There was a fellow in the chair getting a shave, and the first thing we knew we had a lot of fireworks in the hand bowl where they give the shampoos, and the barber jumped and cut the fellow's face, and the fellow jumped up and ran out of the shop! " I have followed this thawing gang since 1912, so I took everything they told me with a grain of salt. I have a conversational knowledge of electricity, and I thought, — " How the deuce did this happen?" So I looked at his method of thawing and began to think about it. I reported to Mr. McInnes that they had had a little trouble, and that was the end of it for a couple of days. Then we got a claim from the agent of the building saying that the shop had been destroyed by the electric current used to thaw, and the claim was turned over to me to investigate. It was the ordinary front-store barber shop, on the ground floor, and directly back from the door was the hand bowl with the combination faucet, where the cold and hot water mix, and a little rubber hose on it. I found that the check-nuts holding the cocks into the bowl, which was porcelain-lined, were burned off, fused, and also the brass nut that was over it. They said they had got a plumber and had already connected up the cold water again, but the plumber had the piece of pipe. It happened the plumbing shop was overhead. So they showed me the pipe, and there were several places on it where the current had passed either from or to the pipe and had melted it out. The faucets were also fused. I talked with the barber, who was an Italian. He said, " Fine, fine; just the same as a small boy's fireworks, — up in the air! The fellow ran out and I couldn't get him back." The whole story was just this: The thawing men had just wires and the old salt barrel. They had grounded the cable in the manhole, and ran their sub or lead from the wire which they cut into the cable to get through the water rheostat and get to the pipe just inside the cellar wall. Now, there was only one possible way that that current could get up to where the damage was done, and that was the fact that the pipe in the building was not disconnected from the house service. In other words, they simply hooked on to it without disconnecting anything. The result was that one end of the line being grounded, the current passed up through the house, and where the water-supply main ran up alongside a drain pipe there was a jam. There was also a jam where the porcelain around the bowl had been broken off putting in the connection — of course the porcelain lining around those bowls is never perfect at the holes — and the current simply jumped from the water pipe to the soil pipe and followed the iron soil pipe back through the ground to make the ground return to the Edison current. This only illustrates that if you are going to use electric thawing you ought to disconnect the house end from the street end in order to prevent any current from coming back in that way if there is a current. I find that most of the men doing thawing down town in the city proper — that is, north of Northampton Street — where direct current is the only service available, simply ground in the manhole and run their power from the manhole through whatever rheostat they are using, — a barrel is about all they use around here. But if they do not disconnect there is always the danger, no matter how little current they use, that there may be a short circuit somewhere in the house to the drain pipe.

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* Superintendent Water Works, Greenfield, Mass.

† Assistant Engineer, Boston Water Department.

The President. I am assuming that the larger part of this discussion will come after the paper has been printed, with all the statistics. It is altogether too valuable a paper and contains too much useful information to be passed over lightly.

WILLIAM F. WOODBURN.

AN APPRECIATION.

In the sudden death of William F. Woodburn, the New England Water Works Association has suffered a real loss. Though not eligible, as a manufacturer's agent, for personal membership, no active member has been more keenly interested in the progress of the Association, or more jealous of its good name.

His work as chairman of the Committee in Charge of Exhibits for several years is well known, and the announcement that "Billy Woodburn will have charge of the exhibits" was always an assurance of success in this feature of the annual conventions.

A clean, capable salesman, his life illustrates in rare degree the influence of a winsome and unselfish personality, and to many engineers and superintendents the thought that no more will he break the routine of their days by his wholesome, honest, good cheer will be a very personal sorrow.

The undersigned take this opportunity to record their sense of personal loss and of loss to the Association, in the death of Mr. Woodburn, believing that it will find echo in the hearts of many other members.

LEONARD METCALF.
FRANK A. BARBOUR.
CHARLES W. SHERMAN.

PROCEEDINGS.

Meeting of June 19, 1918.

The June meeting of the Association included a Field Day and Excursion in conjunction with the Boston Society of Civil Engineers, members meeting at Rowe's Wharf, Boston, at 10.15 A.M., and proceeding by boat of the Nantasket Beach Steamboat Company to Pemberton, where an enjoyable day was spent.

A ball game was held in the morning between teams representing the two organizations, resulting in a victory for the New England Water Works Association.

Dinner was had at the Pemberton Inn at 1.30, followed by a very interesting address on War Conditions, by Maj. Kenneth D. Marlatt, of the Fourth Canadian Mounted Rifles, who was introduced by President Spofford, of the Boston Society of Civil Engineers.

A business meeting of the Association was held later, followed by a boat trip to Nantasket, after which members returned by boat to Boston.

At the business meeting Vice-President Killam presided. Three applications for membership were received, properly endorsed, and recommended by the Executive Committee, and the applicants, viz., H. J. Carroll, Rumford, Me.; LeRoy M. Peterson, superintendent Duxbury Fire and Water District, Millbrook, Mass., and James W. Routh, chief engineer Rochester Bureau of Municipal Research, Rochester, N. Y., were by unanimous vote made members of the Association.

Following discussion on the subject of Priorities, it was voted: That a committee of three be appointed to voice the protest of the New England Water Works Association to the proper authorities against the inclusion of the manufacture of meters, or other water-works supplies, in the class of non-essential industries. Vice-President Killam later appointed, as a Committee on Priorities, Willard Kent, A. E. Martin, and Hiram Allen Miller.

Adjourned.

Attest, WILLARD KENT, *Secretary.*

"Win-the-War-Meeting."

Chipman Hall, Tremont Building,
Boston, Mass., September 11, 1918.

Carleton E. Davis, President, presiding.

The following members and guests were present:

Honorary Members.

E. C. Brooks.
F. E. Hall.
W. T. Sedgwick.
G. A. Stacy.
F. P. Stearns.
R. J. Thomas. — 6.

Members.

S. A. Agnew.
T. C. Atwood.
M. N. Baker.
L. M. Bancroft.
G. W. Batchelder.
C. S. Beaudry.
C. A. Bingham.
A. E. Blackmer.
J. W. Blackmer.
Bertram Brewer.
A. N. Burnie.
E. D. Chadbourne.
R. L. Cochran.
F. L. Cole.
J. E. Conley.
H. R. Cooper.
H. C. Crowell.
John Cullen.
F. L. Cushing.
F. A. Darling.
C. E. Davis.
J. H. Dillon.
J. M. Diven.
A. O. Doane.
H. F. Dunham.
E. D. Eldredge.
Frank Emerson.
B. R, Felton.
F. L. Fuller.
Patrick Gear.
H. T. Gidley.
F. J. Gifford.
H. J. Goodale.
W. M. Gooding.
X. H. Goodnough.
E. A. W. Hammatt.
H. A. Hanscom.
A. R. Hathaway.
D. A. Heffernan.
C. R. Hildred.
J. L. Howard.
A. C. Howes.
J. A. Hoy.
W. F. Hunt.
J. W. Kay.
R. F. Kay.
Willard Kent.
J. A. Kienle.
J. W. Killam.
S. E. Killam.
G. A. King.
T. E. Lally.
P. J. Lucey.
F. A. McInnes.
Thomas McKenzie.
Hugh McLean.
H. V. Macksey.
A. E. Martin.
W .P. Mason.
F. E. Merrill.
G. F. Merrill.
M. L. Miller.
J. J. Moore.
P. T. Mullin.
William Naylor.
Henry Newhall.
R. J. Newsom.
F. L. Northrop.
H. E. Perry.
E. W. Quinn.
G. A. Sampson.
C. M. Saville.
A. L. Sawyer.
W. P. Schwabe.
G. G. Shedd.
C. W. Sherman.
G. H. Snell.
W. F. Sullivan.
H. A. Symonds.
R. L. Tarr.
L. D. Thorpe.
J. L. Tighe.
S. E. Tinkham.
E. J. Titcomb.
E. M. Tolman.
J. H. Walsh.
R. M. Whittet.
H. F. P. Wilkins.
F. 1. Winslow.
I. S. Wood.
M. B. Wright. — 91.

ASSOCIATES.

American City, The, by J. H. Van Buren.
Bond, H. L., Co., by F. M. Bates and J. W. Gleeson.
Central Brass Mfg. Co., The, by M. J. Hirschfield.
Chapman Valve Mfg. Co., by J. T. Mulgrew.
Edson Mfg. Co., by H. L. B. Watson.
Engineering News-Record, by I. S. Holbrook.
Fire and Water Engineering, by Louis Ernst.
Hayes Pump Machinery Co., by F. H. Hayes and J. Howard Hayes.
Hersey Mfg. Co., by J. Herman Smith.
Leadite Company, The, by George McKay, Jr.
Lead Lined Iron Pump Co., by T. E. Dwyer.
Ludlow Valve Mfg. Co., by A. R. Taylor.
Mueller, H., Mfg. Co., by C. J. G. Haas.
National Meter Co., by J. G. Lufkin and H. L. Weston.
National Tube Co., by H. T. Miller.
National Water Main Cleaning Co., by B. B. Hodgman.
Neptune Meter Co., by H. H. Kinsey.
Pitometer Company, The, by E. D. Case.
Pittsburgh Meter Co., by J. W. Turner and V. E. Arnold.
Rensselaer Valve Co., by J. S. Warde, Jr., and C. L. Brown.
Thomson Meter Co., by E. M. Shedd.
Union Water Meter Co., by D. K. Otis and H. W. Jacobs.
United States Brass Co., by G. A. Caldwell.
Warren Foundry & Machine Co., by W. F. Woodburn.
Water Works Equipment Co., by W. H. Van Winkle.
Worthington Pump and Machinery Corp., by Samuel Harrison and E. P. Howard. — 33.

GUESTS.

MAINE. *Augusta*, Roy F. Searle.

MASSACHUSETTS.

Belmont, Prof. Arthur E. Norton.
Boston, James P. Bacon, Mrs. S. E. Killam, Raymond M. Kinsman, N. C. Sipprelle, L. Lee Street.
Cambridge, Thomas M. Mullins.
Danvers, Roger W. Esty and J. Ellison Morse.
Greenfield, Mrs. George F. Merrill and Winthrop T. Noyes.
Marblehead, Henry M. Wilkins.
Peabody, Archie Emerson.
Worcester, Prof. Ira N. Hollis and Hon. John G. Holmes.

RHODE ISLAND. *Bristol*, J. M. Jones.

NEW YORK.

Glens Falls, Ernest L. H. Meyer.
New York City, R. E. Brown.

NEW JERSEY. *East Orange*, Roswell M. Roper.

PENNSYLVANIA.

Philadelphia, E. M. Nichols.
Pittsburgh, George F. Maglott. — 22.

THE PRESIDENT. You notice that the first number on the program is " President's Address," but as this is war time, and we are requested by the authorities in Washington to dispense with all luxuries, the President's address on this occasion will be omitted and we will come directly down to business.

There was considerable discussion as to what we should have in the way of an annual meeting this year; that is, whether we should have the ordinary convention with the usual convention features of excursions and entertainments and so forth; and it was finally decided, and I believe we are all agreed that it was decided properly, that we should cut out this year practically all those features. I think the committee which has planned our program deserves a great deal of credit. The program they have outlined I believe will prove to be a very interesting and useful one, and the reports we have heard lead us to think that there will be a very large attendance this afternoon and to-morrow, considering all the circumstances. Of course the train service is irregular, and even our Secretary has not been able to get here this morning because of train delays. Mr. Sherman is to act as Secretary *pro tem.*, and he will now present the report of the Executive Committee.

MR. C. W. SHERMAN. The applications for membership, properly endorsed and approved by the Executive Committee, are as follows:

Henry F. Beal, superintendent Waltham Water Department, Waltham, Mass.; Isaac S. Walker, Philadelphia, Pa., water supply (general manager New Chester Water Company), sewage disposal; Frank A. Mazzur, Waban, Mass., installation of power and water-works pumping plants.

On motion of Mr. Bancroft, the Secretary *pro tem.* was directed to cast the ballot of the Association for the applicants whose names had been read, and he having done so, they were declared duly elected members of the Association.

MR. SHERMAN. The only other item of business in the Secretary's office here is a letter from our friend Walter H. Richards, of New London, Conn., which I will read.

New London, Conn., September 3, 1918.

Mr. Willard Kent,
Secretary of the N. E. W. W. Association,
715 Tremont Temple, Boston, Mass.

Dear Sir, — As I shall be unable to attend the meeting of September, 1918, I would suggest that if the meeting is, as it should be, an entirely pariotic one, I would like to reiterate my remarks of last September when I urged that all municipal expenditures be reduced to those " necessary for the preservation of life and health." I would suggest also that a copy of the Resolution adopted at that time be sent to the mayor or executive officer of each city in New England represented in the Society.

Furthermore, the circular calling attention to the saving of coal by saving water does not apply to the many cities supplied by gravity which are on the verge of a shortage, particularly should the season be dry, and to such a rigid inspection supplemented by the use of meters might postpone a large expenditure. For instance, in the city of New London the population has increased since 1914 at least 30 per cent., while the consumption has increased but 3 per cent., due to an increased installation of meters and to inspection of fixtures.

Yours truly,
(Signed) W. H. Richards.

The President. What is it your pleasure to do with the communication? I suppose it carries a recommendation that the resolution that was adopted last September be sent to the mayor or executive officer of each city represented in this Association. When Mr. Diven was recently in Washington he had a very interesting talk with the Fuel Administration, and they outlined to him a certain campaign that they proposed to inaugurate; and while of course that would apply particularly to coal, it might very likely cover Mr. Richards' ideas, because it could be made all-embracing to cover those cases where it is necessary to save water for munition purposes. Perhaps Mr. Diven will outline the conversation he had in Washington.

Mr. J. M. Diven. Mr. President, the movement has only just started, and the appointment was made yesterday of a man to take charge of it, — that is, an educational campaign for the saving of water, particularly with the view of saving coal, very much on the lines of the educational plan for the conservation of food, although the idea is to go even further than that. For instance, in our talk it was estimated that the coal consumed in pumping water for the ornamental fountains in the city of Washington, of which, as you all know, there are a great many, every day in the year, would supply five families for a year, or fifteen hundred or more families for a day, with coal that is now wasted to supply the ornamental fountains. And the same proposition applies to lawn sprinklers, which use a great deal of water; and it is possible that next year, when the coal situation may be worse than it has been this year, or even if it is as bad as it is now, an order may be issued to prohibit the use of lawn sprinklers, where coal is used for pumping, or where electricity generated by coal is used, or even where hydro-electric power is used, on the theory that that power might take the place of coal in some other plant. As you know, the Administration has authority to enforce these things; and there is very much hope that the diminution of water waste will run way beyond the war and that we will all be benefited very largely by it in the future.

Mr. Richards suggests the sending of this resolution to the mayors of cities represented in the Association in New England, — but why confine it to New England? We have members all over the country. I think we had better amend the Resolution, if it be considered as a Resolution, so that it shall be sent to all cities represented in the Association, whether located in New England or elsewhere.

MR. SHERMAN. There is another point in Mr. Richards' letter that has not been touched upon, and perhaps he did not make it as strong as he might have in the letter, and that is that many communities having inadequate supplies are facing an early necessity of obtaining of additional supplies at large capital expenditure unless the consumption is kept down. And in view of the Government's recommendation that capital expenditures be limited and investments be kept down to the lowest possible amount for actual necessities, it would be desirable to make sure that a real necessity existed, that is, that there was a shortage of supply not due to wastage of water but to actual growth in the reasonable consumption, before a bond issue ought to be allowed for an extension of the plant. A comparatively small sum spent in maintenance, inspection, repairs, and installation of meters would often make unnecessary a large capital expenditure and bond issue for the installation of a supply.

The motion which Mr. Richards made and which was adopted was this: " I move that it is the sense of this Association that any public work, except that for life and health, be deferred until conditions change." If it was sent out in that form it would be susceptible of a good many different interpretations, I think.

Perhaps it would not be out of place to read what Mr. Richards said in presenting the matter, and then, if it is the sense of the meeting that something along this line should be done, it might be well to instruct the Executive Committee, or some special committee, to draft a resolution or statement embodying the sense of the discussion and of this motion. Mr. Richards said:

> " In a recent editorial in a paper devoted to advertising construction work and tools, the endeavor is made to prove that it is desirable to proceed with municipal construction work regardless of abnormal costs and abnormal conditions; indeed, the existence of these conditions is denied. These conditions are well known to any member of this Association who has undertaken construction work during the past year, whether by contract or by day labor, so that it is only necessary to state them briefly.
>
> " A large proportion of the day labor of this country is done by aliens or near aliens, a large portion of whom have now left this country to fight the battles of their own countries. Naturally they are the most efficient ones who have gone. Thus, while the cost of labor, due to scarcity, has advanced about 40 per cent., the efficiency has declined until the actual value of labor has been reduced at least 50 per cent., and this condition is likely to be exaggerated by the demand for men for our own armies.
>
> " The materials and tools which are required for construction have increased from two to three times in cost over that of years ago. It is, then, safe to say that the cost of any new construction has doubled in two years and is now double the normal or real value. Whether construction at this time is paid for at once or by bonds or securities to be paid by posterity, the investment is twice its normal value. Would any careful business man make an investment without knowing that the future receipts would warrant the expenditure? It would seem that all new work, except that immediately demanded for the preservation of life and health, should be deferred until normal conditions are restored, for economic reasons.
>
> " But there is another reason: this country is at war, — your country, my country, is in jeopardy. Every dollar, every bit of energy, all the skill and efficiency should be devoted to saving it from destruction, and until that is accomplished nothing else matters. If a camp needs a water supply, build it and charge it up to profit and loss; but do not build anything that can be deferred until the future."

Mr. Diven. If a resolution is to be adopted, wouldn't it be well to ask Mr. Richards to word it in proper form? But, on the other hand, hasn't this matter been taken care of already? There is a Government order forbidding the issue of bonds except upon approval by the Government; and, more than that, the price of materials is almost prohibitive and we couldn't get them if we wanted them. However, I think that it would be well for us to pass some resolution, so I suggest that it might be well for Mr. Richards to put it in proper shape, elaborating it a little more.

On motion of Mr. George A. King it was voted that Mr. Richards' letter be referred to the Executive Committee with power to take such action as seems desirable.

Report of Priorities Committee.

The President. The next matter on the program is "Report of Priorities Committee," Willard Kent, chairman. In Mr. Kent's absence, I, perhaps, may make a statement, and that is that there is no report of the Priorities Committee ready at this time, because the committee has not been able to meet. The situation at Washington has been such that no application for general priority would be considered. Specific cases would be taken up, but no general priority, for instance, as in the case of meters or any other broad line like that, or water works as a whole, would be granted. And in the new priority order that has just been issued, published in the papers day before yesterday, you will notice that water companies and water works are in Class 2. Possibly it may hurt our pride a little to think that food is in Class 1 and water is in Class 2, — because we all know that water is very much more important than food, — and that hospitals and sanatoriums are in Class 1 while water companies are in Class 2, — and yet what hospital or sanatorium could operate if the water works are not kept up?

But you read a little further in the report which goes with this publication and you will see that one of the fundamental principles governing the establishment of this list was the need of stimulating production. I suppose the food industries really do need to be stimulated more than water-works people. I think we all understand that we need to be curtailed rather than stimulated in our production, if possible; and, of course, we understand the necessity of stimulating food production in this country, not only for ourselves but for our allies.

I had some further curiosity to notice, as possibly you noticed, that copper and brass works are in Class 3 or Class 4. It is a curious study how it works out, because, while we are in Class 2, the very essentials we depend upon for our operation are in Class 3 and Class 4.

I think there is no question that the Priorities Committee should be continued, and the suggestion has been made that the committee should be enlarged by the addition of one or two members representative of the manufacturers. There are now three active members on the committee, the Secretary, Mr. Martin, and Mr. Miller, and I personally believe that the committee could work a good deal more effectively if there were representatives from our associate members, the manufacturers, on it. What would be the thought of the Association as to continuing the Priorities Committee and enlarging it to include two manufacturers or their representatives?

MR. DIVEN. I make that motion, Mr. President.

THE PRESIDENT. Would you make any suggestion as to what interests should be represented?

MR. DIVEN. Of course coal is our principal need; but I would suggest a representative of the meter manufacturers, above all. And I think that the Fuel Administration will take up that matter and try to secure priority for materials for manufacturing meters, and for the shipment of meters, because the Fuel Administration is going to advocate pretty strongly the use of meters to cut down waste. Outside of meter manufacturers and the coal I would suggest the pumping plants, and especially repair parts.

THE PRESIDENT. The repair-parts question is one I think this Priority Committee will have to take up. I haven't yet been able to convince the Priority Board that an emergency repair is in a class by itself.

The motion that the Priorities Committee be continued and enlarged by adding two representatives of the manufacturers was adopted.

COMMITTEE TO NOMINATE OFFICERS.

On motion of Mr. William F. Sullivan, the President was authorized to appoint a nominating committee of five to nominate officers for the ensuing year.

The President appointed as the committee Charles W. Sherman, George W. Batchelder, J. W. Kay, Bertram Brewer, and F. A. McInnes.

Mr. Henry A. Symonds read a report submitted by Mr. George A. Carpenter on the subject of the " Intimate Connection between the Saving of Water and the Conservation of Coal." The paper was discussed by Mr. Charles W. Sherman, the President, and Mr. J. M. Diven.

Mr. F. J. Gifford presented the report of the Special Committee on Frozen Water Pipes. Mr. Frank A. McInnes, a member of the committee, and Mr. Caleb M. Saville discussed the subject.

Adjourned to 2 P.M.

AFTERNOON SESSION.

The first matter on the program for the afternoon session was an address on " The Fuel Situation in New England," by James J. Storrow, Fuel Administrator for New England. In the absence of Mr. Storrow, who had been obliged to go to Washington, Prof. Ira A. Hollis, the engineer of the New England Fuel Administration, made an address on the subject which had been assigned to Mr. Storrow.

President Davis read a telegram from Edward E. Minor, superintendent, New Haven, calling attention to the fact that water works had been placed in the second class in the Priority List, and asking that some action be taken by the Association to secure a reclassification.

PRESIDENT DAVIS. We miss to-day one of our active members, Mr. Coggeshall, of New Bedford, who has been very critically ill, but who we now hear is on the road to recovery. I think it would be a very happy thing if some resolution could be adopted at this time conveying our kindest remembrances to Mr. Coggeshall and expressing our hope for his speedy complete recovery. Will anybody make a motion to that effect?

Mr. J. M. Diven. Being perhaps the next oldest water-works man to Mr. Coggeshall in the Association, I will take great pleasure in offering such a resolution.

President Davis. I suppose that carries with it the provision that Mr. Diven will draw up the resolution that the Association will send, and I will put the motion in that way.

The motion was adopted.

Major Charles R. Gow, construction quartermaster, Boston, gave a description of the Quartermaster's Terminal at Boston required for war work.

Thomas C. Atwood, resident supervising engineer, described the construction of the Squantum Destroyer Plant.

The session was brought to a close by an address by Prof. William T. Sedgwick, Past-President of the New England Water Works Association, chairman of the Massachusetts Division of the National Security League, entitled, "From Peace to War, from War to Victory, from Victory to Judgment."

Adjourned.

Morning Session, Thursday, September 12, 1918.

President Davis in the chair.

The Secretary read the following list of applications for membership, duly approved by the Executive Committee:

J. W. Gummo, Watervliet, N. Y., resident engineer and superintendent of water supply for the city of Watervliet; Roswell M. Roper, East Orange, N. J., member New Jersey Inland Waterways, U. S. Government Inland Waterways, and East Orange, N. J., Water Works; George E. Gormley, Abington, Mass., water commissioner. — 3.

On motion of Mr. J. M. Diven, the Secretary was instructed to cast the ballot of the Association in favor of the applicants named, and he having done so, they were declared elected members of the Association.

Mr. Davis A. Heffernan, superintendent of water works, Milton, Mass., read a paper entitled, "Practical Methods for Detecting Leaks in Underground Pipes." President Carleton E. Davis, Mr. J. M. Diven, Mr. George F. Merrill, Mr. A. E. Martin, Mr. William Naylor, Mr. Frank J. Gifford, Mr. George E. Gormley, Mr. H. D. Gedley, Mr. Samuel A. Agnew took part in the discussion.

For the benefit of those members who were not present at the meeting on Wednesday, September 11, Mr. Frank J. Gifford gave a résumé of the report of Committee on Frozen Water Pipes, discussion of this subject being resumed and participated in by Mr. George F. Merrill, Mr. J. M. Diven, and Mr. Thomas E. Lally.

Report of Committee on Uniform Accounting.

Mr. A. R. Hathaway. Mr. Sawyer, the chairman of our committee, could not be here to-day. He was here yesterday and we had a little conference, and he wished me to say a few words this morning. This subject is a very important one, and while we cannot afford what we would like, — as a committee we have been unable to get together formally, — but there has been some discussion informally among some of the members, and I hope that you will allow us to continue and we may work out something or other later on. The status of the committee and the work that it has not accomplished, I was thinking in my own mind, is expressed somewhat by a little incident I heard of, where there was a show in a town and a rain had come up, and the stage manager had to come out in front of the stage and address an empty house. He said, "Ladies and Gentlemen: As there is no one here I will dismiss you all; the performance of the evening will not be performed but will be repeated to-morrow evening." [*Laughter.*] I hope, as an attempt to keep the show alive, that you will allow this committee to still live.

President Davis. I think there is no question that the Association ought to continue that committee. It is altogether too good a committee and working on too important a matter to let the subject drop. Apparently no motion is necessary, so that I will state that the committee is continued.

Report of Committee on Standard Specifications on Water Meters.

Mr. Charles W. Sherman. Mr. President, the committee reports progress. We had thought of reporting a tentative draft — perhaps it would be too much to call them specifications — but of certain suggestions which might be submitted to the meeting for discussion. But as it did not prove practicable for us to discuss these matters with the manufacturers, and as it appeared through communication with one or two of them that if we presented this and started a discussion on it we might be barking up the wrong tree, we thought it would be better to report only that we had made a little progress. The committee has not been able to meet in session and has done whatever it has done by correspondence.

PRESIDENT DAVIS. Then that committee will be continued.

REGARDING PRIORITIES COMMITTEE.

PRESIDENT DAVIS. Yesterday the Association voted to continue the Committee on Priorities and increase its membership by two representatives from the members of the manufacturers, and those additional members will be Mr. Seth D. Higley and Mr. William Woodburn. That leaves the membership of the Priorities Committee, Mr. Willard Kent, Mr. A. E. Martin, Mr. H. A. Miller, Mr. Seth D. Higley, and Mr. William Woodburn.

In that connection there was some little discussion yesterday about the desirability of protesting to the Priorities Board in Washington against the inclusion of water companies and water works in Class 2 rather than in Class 1. The suggestion was made by Mr. Minor yesterday, in the telegram which I read, that the Association should go on record by a protest to Mr. Baruch asking that he reconsider the matter. The subject was discussed somewhat this morning in the Executive Committee, and it seemed to be the conclusion of the Executive Committee that it was best not to make a protest from the Association as a whole but leave the matter to this Priorities Committee. I feel very strongly that that is the proper attitude to take, — that it might perhaps be even worse than useless to protest as an Association, that it might put us in a wrong position with the Priorities Board and perhaps prejudice our case in the future on any particular points that we might want to bring up for their consideration, — and accept what the Priorities Board has put out as being their best judgment at the present time. As was suggested yesterday, we feel that we are just as important, or perhaps more important, than food. But I believe, and I think most of you will agree with me, that there will be absolutely no question about water works getting the necessary coal in any event. I am constrained to tell you a story that I told the Executive Committee this morning, illustrating my viewpoint on the matter. It is a very old story, and perhaps old enough to be new. There was a church organist one time giving a very beautiful piece, and after the conclusion the small boy who had been pumping the organ in the rear came out and said to the organist, — " That was a magnificent piece we gave, wasn't it? " And the organist said, " You little devil, what did you have to do with it? You go back and pump the organ." So the boy went back, and the organist was giving another piece, and just as he came to the most thrilling crescendo of the whole thing the boy stopped pumping and the music ended up in a screech. Then the boy came out and said, " Well, you found out I had something to do with that, after all." And it is the same situation with our pumping stations; if they quit giving us coal they will soon find out that we have a good deal to do with running the country at the present time; and if it comes to a question of even munitions plants or food factories as against the water supply I feel perfectly confident that we will get all the coal we need to run our pumping stations when it comes to a show-down. I believe that it is so absolutely true that we would be simply wasting our time and perhaps prejudicing our cause if we made a protest now, because they all know this: that we are the only universal, fundamental, absolute necessity in the whole country. So that the Executive Committee felt it best not to make any formal protest, and unless there is some different feeling on the floor I think we will consider that that stands.

Adjourned.

AFTERNOON SESSION.

The Secretary read the application for membership, approved by the Executive Committee, of Winthrop T. Noyes, Greenfield, Mass., member Board Water Commissioners.

On motion of Mr. Frank L. Fuller, the Secretary was instructed to cast the ballot of the Association in favor of the applicant named, and he having done so, the applicant was declared to be elected a member of the Association.

Mr. A. E. Martin. A number of the members have expressed to me personally — and I presume they have talked it over amongst themselves besides — their appreciation of the address which Professor Sedgwick gave us yesterday, and quite a few have suggested that undoubtedly each member of the Association would like to have a copy of the address in his possession. The Association spreads over a good deal of country, and it might be well if a copy of this address could be put into the hands of each member so that he might have it published in his local newspaper as something coming from this Association. I make a motion, therefore, that that address be published ahead of the issue of the Proceedings and of the Journal and mailed to the members of this Association.

The motion was seconded by Mr. Frank L. Fuller.

President Davis. Does anybody have anything to say about that motion which has been made and seconded, — that Professor Sedgwick's paper be printed in advance of the Journal and distributed to all the membership? It seems to me that is a most admirable suggestion because that paper was very well worth wide distribution. If there is no discussion we will have a vote.

The question was put and the motion carried.

Mr. Charles T. Main, mill engineer, Boston, read a paper entitled, "The Fuel Situation in New England, and Necessity of Careful Planning in Order to Get Through the Year on a Restricted Amount." President Carleton E. Davis, Mr. J. M. Diven, Mr. Frank L. Fuller, Mr. George A. Stacy, and Mr. John J. Moore took part in the discussion.

Mr. John J. Moore, consulting engineer, Boston, read a paper entitled, "Expediency of Raising Water Rates to Offset Increased Costs." The discussion was participated in by President Carleton E. Davis, Mr. Frank L. Fuller, Mr. Charles W. Sherman, Mr. J. M. Diven, Mr. Hugh McLean, Mr. Henry A. Symonds, and Mr. Samuel A. Agnew.

An informal discussion was had on the subject of "Experience in Labor Troubles." This was participated in by President Carleton E. Davis, Mr. Frank L. Fuller, Mr. Bertram Brewer, Mr. H. V. Macksey, Mr. J. M. Diven, Mr. A. E. Martin, Mr. Patrick Gear, and others.

Adjourned.

EXECUTIVE COMMITTEE.

Meeting of the Executive Committee of the New England Water Works Association, Boston Harbor, June 19, 1918.

At a meeting of the Executive Committee of the New England Water Works Association, held this day on the boat of the Nantasket Beach Steamboat Company en route to Pemberton, there were present Samuel E. Killam, Frank J. Gifford, A. R. Hathaway, Lewis M. Bancroft, Henry V. Macksey, and Willard Kent.

Three applications for membership were received, viz.: H. J. Carroll, Rumford, Me.; LeRoy M. Peterson, superintendent Duxbury Fire and Water District, Millbrook, Mass., and James W. Routh, chief engineer, Rochester Bureau of Municipal Research, Rochester, N. Y.

Discussion was held on the subject of Annual Convention, and it was the opinion of the majority of those present that it should be omitted.

Adjourned.

Attest,

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., July 10, 1918, pursuant to call of the President.

Present: President Carleton E. Davis, and members Samuel E. Killam, Henry V. Macksey, Frank A. Barbour, Thomas McKenzie, Henry A. Symonds, Lewis M. Bancroft, and Willard Kent.

On motion of Mr. McKenzie, seconded by Mr. Barbour, it was voted: That the Association hold a business meeting of two days' duration at Tremont Temple, Boston, Mass., September 11 and 12, 1918.

Mr. George A. Carpenter was appointed a committee to look into the subject of " The Intimate Relation between the Saving of Water and the Conservation of Coal."

President Carleton E. Davis was, by unanimous vote, appointed a committee to issue, in behalf of the Association, a circular and poster in relation to the conservation of water.

Adjourned.

Attest,

WILLARD KENT, *Secretary.*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., September 11, 1918.

Present: President Carleton E. Davis, Samuel E. Killam, Frank J. Gifford, A. R. Hathaway, Henry A. Symonds, L. M. Bancroft, and by invitation, Charles W. Sherman, who acted as Secretary *pro tem.*

Three applications for membership were received and unanimously recommended therefor, viz., Henry F. Beal, superintendent water works, Waltham, Mass.; Frank A. Mazzur, Waban, Mass., and Isaac S. Walker, general manager New Chester Water Company, Frankford, Philadelphia, Pa.

The report of the Committee on Award of Dexter Brackett Memorial Medal was read and referred to a committee consisting of the Board of Editors and Charles W. Sherman.

Adjourned.

CHARLES W. SHERMAN, *Secretary pro tem*

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., September 12, 1918.

Present: President Carleton E. Davis, Samuel E. Killam, Henry V. Macksey, Thomas McKenzie, Frank J. Gifford, A. R. Hathaway, Henry A. Symonds, Lewis M. Bancroft, and Willard Kent.

Four applications for membership were presented and the applicants were by unanimous vote recommended therefor, viz., Winthrop T. Noyes, water commissioner, Greenfield, Mass.;

J. W. Gummo, superintendent water works, Watervliet, N. Y.; Roswell M. Roper, superintendent water works, East Orange, N. J.; George E. Gormley, water commissioner, Abington, Mass.

Willard Kent, Samuel E. Killam, and Frank J. Gifford were, by vote, constituted a committee to arrange for hotel accommodations for the winter meetings of the Association.

The action of the Secretary in returning to Mrs. Maybury the dues of William E. Maybury received subsequent to his death was approved.

Adjourned.

Attest,

WILLARD KENT, *Secretary.*

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OFFICERS

OF THE

New England Water Works Association.

1918.

PRESIDENT.

Carleton E. Davis, Chief, Bureau of Water, Philadelphia, Pa.

VICE-PRESIDENTS.

Samuel E. Killam, Supt. Pipe Lines and Reservoirs, Metropolitan Water Works, Boston, Mass.
Henry V. Macksey, Supt. of Public Works, Woburn, Mass.
Frank A. Barbour, Consulting Hydraulic and Sanitary Engr., Boston, Mass.
Percy R. Sanders, Supt. Water Works, Concord, N. H.
Thomas McKenzie, Supt. Water Works, Westerly, R. I.
Henry R. Buck, Consulting Engineer, Hartford, Conn.

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SECRETARY.

Willard Kent, Civil Engineer, Narragansett Pier, R. I.

EDITOR.

Henry A. Symonds, Civil Engineer, 70 Kilby Street, Boston, Mass.

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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of about 1 000 men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are FOUR dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues TWENTY dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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CAMP DEVENS AND ITS WATER SUPPLY.*

BY FRANK A. BARBOUR.

Camp Devens is one of sixteen similar cantonments constructed for the reception and training of men drafted under the conscription law of May 18, 1917. These camps — the locations of which were chosen by the commanding officers of the six army departments — ranged from Camp Devens to Camp Lewis, Washington, in the extreme northwest, and Camp Travis, Tex., in the extreme south, each having a tributary population of about 7 000 000 people.

The appropriation bill providing funds for construction did not become law until June 15, 1917, or eighty days before the date when the first quota of the draft were to arrive at the camps, but, under the Council of National Defence, the Committee on Emergency Construction, of six members (two of which, Messrs. F. L. Olmstead and M. C. Tuttle, were from Boston), had already made good progress in preparation for construction.

Brig.-Gen. I. W. Littell had been appointed officer in charge of cantonment construction, and Mr. F. M. Gumby (now Colonel), of Mr. Chas. T. Main's office, Boston, had been placed in charge of the engineering work of the Cantonment Division. A subcommittee of the Committee on Engineering Construction, composed of Messrs. Leonard Metcalf, Geo. W. Fuller, and A. E. Phillips, had been active on the problems of preliminary planning, sanitation, and engineering relations to cantonment work.

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* This description of Camp Devens is based on an informal talk illustrated by lantern slides, given before the Association, March 13, 1918. Some references to the operation of the camp founded on data furnished by Major E. W. Briggs, officer in charge of Utilities, have been added. Discussion published in June, 1918, JOURNAL.

Typical cantonment layouts were prepared at Washington, but it was necessary to adapt these to varying conditions at the different camp sites, to find water supplies, determine the method of sewage disposal, and plan railroad connections. With no men to spare in the Engineer or Quartermaster's Corps, a call was made for engineers to investigate the condition at each cantonment site. For the work at Ayer, a preliminary Board of Engineers, composed of Messrs. F. P. Stearns, H. J. Kellaway, and the writer, was appointed on May 25. On May 29 four survey parties, under Mr. George H. Wetherbee, were in the field, and between this date and June 9, a survey of 1 500 acres of rough, scrub-oak covered country was completed with sufficient accuracy to make possible the preliminary layout of the regimental units, the roads, the railroad connections, and the water and sewerage systems — the source of supply having been selected and the method and location of disposal works determined. Such results were only possible by working day and night, and acknowledgment should be made to the spirit displayed by the men engaged on the preliminary surveys.

On June 10, general plans and a report were submitted to the Cantonment Division at Washington and the results approved. Capt. Edward Canfield, Jr., U. S. Army (now Lieutenant-Colonel), had on the preceding day been appointed constructing quartermaster, and on June 14 arrived in Ayer. Fred T. Ley & Co., of Springfield, was selected as contractor by a special committee of the Committee on Emergency Construction, the contract being signed on June 19. Active construction began on June 25, or about seventy days before the date (September 4) set for the reception of conscripted men in camp — during which period it was proposed to do work involving an average expenditure of about $100 000 per day.

The construction quartermaster was the official representative of the Government, the disbursing official and the general manager of the work, and to him the engineers, the contractor, and the auditors were subordinate. No better man than Captain Canfield after the work started, no form of contract other than cost plus a the work, and to him the engineers, the contractor, and the ditors were subordinate. No better man than Captain Canfield could have been chosen, and to his poise, temperament, ability, courage, and knowledge of how far action might proceed in the absence of direct orders from Washington, the completion of the cantonment within the time limit is to be largely credited.

The Contract.

The contractor was selected on the basis of experience and capacity, not by competition — the reason for such action being set forth in the preamble to the contract, which reads that, "whereas war exists and the United States urgently needs the work hereunder described, whereas because of disturbed condiditions it is advisable to depart from usual procedure, and whereas the contractor has had experience, has an organization and is ready."

The contract was of the cost plus a sliding-scale fee with maximum upset fee type, the percentage reducing with increasing value of contract and the fee under no conditions to exceed $250 000. The contractor was to furnish all labor, tools, supplies, and equipment, and all material not purchased by the Cantonment Division. He was to be paid a percentage on all costs except freight on material ordered from Washington, including transporting, unloading, repairing, and dismantling equipment; the salaries of his resident engineers and superintendents; on fees for bonds, — in short, on the entire cost of the work in the field as it might be determined by the constructing quartermaster after checking of all labor and all materials by the field auditor. The contractor was allowed a definite schedule of rental for equipment, and he was not to depart from the scale of wages paid in the locality without the previous consent of the constructing quartermaster. No salaries of executives, no expense of the contractor's main office, no overhead, and no interest on capital or borrowed money was allowed. Above all other elements in the contract was the requirement that, in the shortest possible time, the contractor should furnish the labor, materials, tools, machinery, equipment, facilities, and supplies necessary to the completion of the work. With time of completion so important, and with so much of the designing necessarily done from day to day, as data were collected after the work started, no form of contract other than cost plus a fee was practicable, particularly in view of the existing conditions of the labor and material markets.

As to the cost of the work, while materials were generally purchased well below the market level, the prices paid for labor and the lowered standard of production inevitably made the cost greater than would be the case under more normal conditions. In the opinion of the writer, the organization and management of the contractor were good, and the work done as economically as the existing circumstances permitted.

The following tabulation shows the prices paid for labor and the maximum number employed. Lower prices would not have made possible the obtaining of the men necessary to the completion of the work in the time required.

	Wages per Hour.	Per 10-Hour Day.	Time Over 8 Hours.	Maximum Number Employed.
Laborers	$0.37½	$4.13	Time and a half	5 000
Carpenters	.65	7.15	Time and a half	3 500
Electricians	.70	7.70	Time and a half	90
Steamfitters	.78	9.36	Double time	300
Plumbers	.70	8.40	Double time	175
Cement finishers	.70	7.70	Time and a half	75
Shovel runners	.83⅓	10.00	Double time	8
Tinsmith	.70½	8.46	Double time	30
Steam-fitters' helpers	.48	5.76	Double time	100
Blacksmiths	.50	5.50	Time and a half	40
Painters	.62½	6.87	Time and a half	40
Masons	.75	8.25	Time and a half	10

A government field auditor and a large force of assistants checked all material delivered, took the time of all men employed in the work, inventoried all equipment, witnessed payment of wages, and in general was responsible for the approval of all bills for labor, material, and other expenses as a precedent to the issuing of a government check by the constructing quartermaster.

Payments to the contractor were to be made as soon as bills were approved and the money was available, but, despite this arrangement, the amount of the contractor's money tied up was, at times, very large, and after allowing for overhead and interest charges, for which the Government made no allowance, the actual net return to the contractor was probably less than two per cent. of the value of the contract as completed.

[illegible] capacity. For distribution of the temporary supplies, wrought-iron or steel pipe laid on the surface was used.

[illegible]
of the value of the contract as completed.

HOUSING AND FEEDING CONSTRUCTION FORCE.

Before undertaking the description of the work done, a word as to the housing and feeding of the employees and the sanitary control of the camp during construction may be of interest.

The location of the cantonment made necessary provision for housing and feeding practically all the men engaged on the work — or a maximum at one time of 9 176 men. On June 19 the first of the contractor's force came on the grounds accompanied by a carload of tents for temporary purposes. The erection of telephone lines, an office 43 ft. by 306 ft. the latter built in less than thirty-six hours), and wooden barracks of which there were forty (each 16 ft. by 104 ft.), for the housing of the laborers, constituted the first work done. As the barracks were completed, the mechanics were moved from the tents and housed therein — an attempt at economy which later experience proved a mistake, when it was found that a number of the barracks were infested by bedbugs.

In all — including laborers' quarters, offices, sawmills, stables, shops, and storerooms — the contractor constructed 150 temporary buildings, at an expense of approximately $325 000.

A commissary was provided by the contractor and operated under a subcontract by the Baldwin Company, meals being served on the cafeteria plan at actual cost, as determined by auditing of all accounts, — the Government furnishing all equipment and supplies and the subcontractor being paid a lump sum for his services in management during the run of the work. Thirty buildings were erected for commissary purposes, 400 men being employed in this department, and over 17 000 meals being served per day.

The obtaining of a temporary water supply was one of the early problems — solved at first by the driving of two small groups of 2½ wells and pumping to small wooden tanks located near the contractor's office and the stables.

As soon as the necessary pipe could be obtained, an 8-in. connection was made with the system of the town of Ayer — this system having been proved capable of furnishing 250 000 to 500 000 gal. per day in excess of the town's needs, by a test-pump run of ten days at maximum capacity. For distribution of the temporary supplies, wrought-iron or steel pipe laid on the surface was used.

SANITARY WORK DURING CONSTRUCTION.

The sanitary control of the camp during construction, necessary to keep it clean and healthy for the incoming troops, was one of the big problems. With 9 000 men (the majority living and eating within the confines of the work), with no sewerage facilities, with a highly polluted river flowing past one of its boundaries, and with several small bodies of water within its limits ripe for the development of malaria via the mosquito route, there was obvious opportunity for the exercise of skill in meeting the problem. Fortunately, in Capt. (now Lieut.-Col.) Glen I. Jones, U. S. Army, who reported to the constructing quartermaster on June 19, as sanitary officer, the right man for the work appeared, and to his ability, technical knowledge, hard work, insistence that orders be followed, and ability to tactfully coöperate with all elements, is due the fact of an entire absence of insect, food, or water-borne disease during the period of construction.

A brief description of the work of the sanitary corps may be of interest, and perhaps of value in other similar undertakings.

First, in the absence of a water supply, all wells on adjacent farms were examined and the water analyzed. As is too frequently the custom, the wells were often too near the premises and the water found to be contaminated. Signs forbidding the use of such water were posted; but to these the workmen gave little heed, and all dangerous wells and springs were soon filled up. Systematic analyses were made of all water of which the use was permitted.

Another phase of the early work was the prevention of such soil pollution by human excrement, garbage, and waste water as might result in the transmission of disease. Pits 9 ft. deep, 11.5 ft. long, and 22 in. wide were dug for the reception of excreta. These pits were covered with wooden boxes, with six holes cut in the top — the holes having self-closing covers. The boxes were sealed tight with sand at the ground surface, and a tin funnel, connected through the side, served as a urinal and prevented soiling of the seats — the entire arrangement being intended to make the pits absolutely fly-proof. As many as twenty latrines of the type just described were placed in a single day, and soon there was no excuse for any workman fouling the surface of the ground. The boxes were daily burned out with fuel oil and straw, unslaked lime was deposited in the pits, the inside of the box swabbed with a mixture of lampblack and oil, and the seats scrubbed with soap and water and standard disinfectant — all this to make an unfavorable breeding place for flies. When filled to within 18 in. of the top, the pits were burned, filled with earth to the surface, covered with burlap soaked in fuel oil (to trap flies and larvæ), and this again covered with additional earth to a level several inches above the ground surface.

Kitchen drainage from the commissary was discharged into cesspools in porous soil, these cesspools being burned and backfilled as soon as plugged by grease, and others excavated. All garbage from kitchen and from the laborers' shanties was systematically burned.

Examination proved that the malaria-carrying type of mosquito was present in considerable numbers in the area adjacent to the small ponds, near which the laborers' shanties were located. Work was therefore necessary to prevent the development and spread of malaria. Rifle Butt pond and several other small bodies of stagnant water were filled or drained dry, and the larger ponds were treated with fuel oil by the drip system — 5-gal. cans being placed at the shore line on the four points of the compass with wicks stuck in holes in the bottoms of the cans. The slowly dropping oil, spread by wind action, effectively covered the entire surface, and soon mosquitoes practically disappeared from the work.

To meet the danger of infection by typhoid carriers, all those working in the commissary and having to do with the food were subjected to the usual test. One typhoid carrier was found and discharged — this one case fully justifying the precaution.

Reports were obtained from the State Board of Health of any epidemic condition of typhoid or other infectious epidemics in the state, and of any cases which apparently had originated in the camp. No such latter cases were reported, but advices as to typhoid and diphtheria in Gardner were made the basis of discharging some twenty mechanics from that town, to prevent infection due to their returning home at the end of each week.

Open-air shower-baths were constructed near the laborers' and mechanics' quarters, and orders were issued that these facilities should be used by the workmen. It was thought by some that the laborers might not respond, but such was not the case, the Italians and other foreign laborers eagerly taking advantage of the opportunity for cleanliness, and proving much more amenable to sanitary regulation than the mechanics. The work of the sanitary corps cost about $100 per day; the record of having prevented — in a camp of 9 000 workmen without sewerage facilities — the development of any case of infectious disease speaks for itself. For the preceding description of the work done in sanitation the writer is largely indebted to a statement prepared by Lieut.-Col. Jones.

Engineering Work in the Field.

General plans of the cantonment showing typical layouts of the regimental units, — either in a straight line or U-shaped, — typical plans of the arrangement of buildings in each unit, typical plans of the layout of water distribution and sewerage systems, detailed plans of buildings, plumbing, piping, and wiring and general specifications of all work, were furnished from Washington.

The engineering work on the ground included the making of topographical surveys, the adapting of the general layout to local conditions, the discovery and planning of the water supply, the design of sewerage and sewage-disposal systems, the planning of electric supply and distribution lines, the planning of the central heating plants and distribution lines, the staking out of all buildings, roads, water pipes, sewers, drains, electric and heating lines, and the supervision and inspection of the work.

The furnishing of typical plans of layout, detailed plans of standard structures and general specifications so as to insure that the results in all cantonments would be uniform and right in the essential elements, and the delegation of sufficient authority to those in the field to adapt these plans to local conditions alone made possible the progress necessary to completion within the scheduled time, and to those men, who planned this division of responsibility between Cantonment Headquarters and the constructing quartermaster on the job, great credit is due.

N. E. W. W. ASSOCIATION,
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BARBOUR ON
CAMP DEVENS
WATER SUPPLY.

General Layout of Cantonment.

Camp Devens was originally planned for a division of troops consisting of ten regiments of infantry, three of artillery, one engineers' regiment, one field signal and telegraph battalion, one division headquarters, and ammunition, supply, engineers,' and headquarters' trains — or for approximately 38 000 men and 12 000 horses.

The typical general layout called for two main parallel roads — about 70 ft. apart — extending through the camp, along which were to be strung the various regimental units with occasional breaks for fire stops. Between these roads are located the barracks and lavatories, and at intervals of some 400 ft. connecting crossroads gave access to the kitchen end of the barracks. Along the outside road the regimental storehouses were placed — this road serving as the main artery for travel and for the transportation of supplies from the division storehouses located at the railroad. This road also formed the line between the men's quarters and the stables and sheds. Inside of the inside parallel road the officers' quarters were located, facing the drill field or parade ground.

At Ayer the rough topography and area available made it necessary to materially depart from the typical straight-line or U-shape plan — the layout comprising a pear-shaped section on the lower ground with the apex of its larger circle resting on the tracks of the Worcester and Nashua Division of the Boston and Maine Railroad (where the storehouses, coal trestle, and refrigeration plant were located), and its smaller apex pointing westward towards the Nashua River, together with a rectangular annex extending southwesterly over the higher plateau. Further to the southwest, on high ground overlooking the Nashua River, the hospital was placed, and about a mile to the north were located the rifle ranges and the remount station.

Type and Number of Principal Buildings.

Taking as an example an infantry regiment, the typical unit layout consisted of twelve two-story barrack buildings grouped in three rows and twelve lavatories, one for each barracks building.

A Company Street.

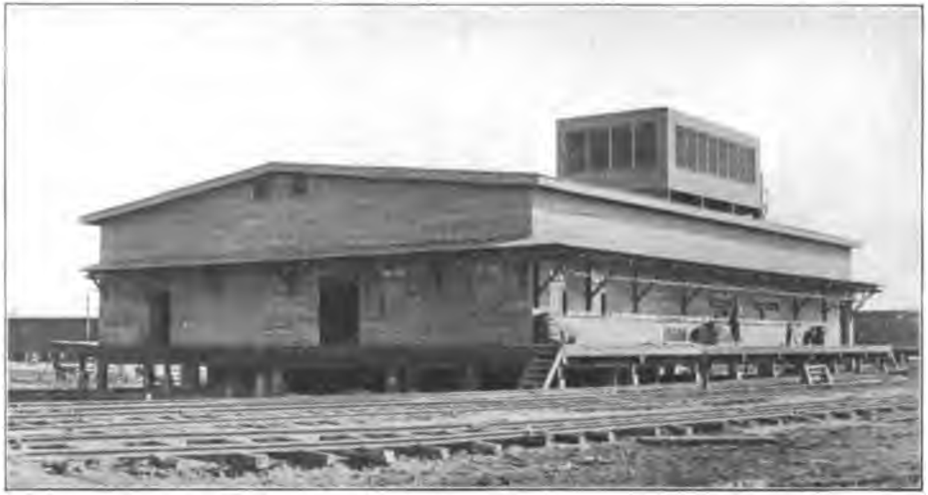
Y. M. C. A. Assembly Hall.

After considerable discussion of the relative merits of canvas and of wooden barracks, it had been decided by the Secretary of War to use wood in the sixteen cantonments, and to provide all reasonable water, sewerage, heating, and lighting facilities — such as would encourage maximum cleanliness, guarantee the best sanitary conditions, and make the first experience of camp life not too rough to the new army of conscripted citizens.

The original barrack buildings for infantry were two-story structures 43 ft. by 140 ft. by 18 ft. from sill to wall plate — the upper floor and one half of the lower floor being devoted to sleeping quarters and the remainder of the lower floor to mess hall and kitchen. These barracks were originally designed to hold 200 men — giving about 375 cu. ft. of air per man. Before completing of the cantonment, however, modifications were made, and additional buildings added so as to increase the air volume to about 500 cu. ft. per man.

Wooden posts, sunk 3.5 ft. in the ground, with footing blocks, form the support. The walls consist of one-ply roofing felt placed on the studs and covered on the outside with novelty or shiplap siding, with wooden sheathing on the inside to the bottom of the windows and wallboard above this level, the enclosed air space thus providing good insulation. Floors consisted of two thicknesses of boards with paper between. The roof was boarded and covered with two-ply felt, and provided with a ventilator extending along the ridge. All buildings were electric lighted and heated either by steam or stoves, Officers' quarters were 20 ft. wide and of varying length, the standard room being 8 ft. 4 in. by 10 ft. 6 in. by 7 ft. 6 in. high, and containing 650 cu. ft. The officers' quarters were boarded and covered on outside by battened roofing felt without exterior siding, and lined with wallboard.

The lavatories have a concrete floor and foundation well, and vary in size — that for a 200-men barracks being 21 ft. by 56 ft. and containing 12 water-closets, 20 shower heads, 2 trough urinals, and 2 trough lavatories — the water from lavatories wasting through the urinals. The lavatories were heated and furnished with hot water for the showers from horizontal steel tank heaters with steam coils, when the building was steam heated, and with vertical heaters, burning anthracite coal, where stove heated.



THE REFRIGERATING PLANT.

The rough topography and the abrupt changes in ground surface made the work of setting batters quite an undertaking, and, with one end of a 200-men barracks sunk several feet in the ground, the posts on the other end were frequently 12 ft. or more high. Cross bracing of these high posts and the boarding in of the irregular space below the lower floor was necessary and involved a very considerable expense.

In addition to the large two-story barracks, there are others varying in size from 30 ft. by 60 ft. to 30 ft. by 80 ft. — the total barracks and officers' quarters equaling about one quarter of the total number (approximately 1 400) of buildings in the cantonment. The other buildings include 338 lavatories, 20 administration buildings, 15 regimental medical buildings, 43 regimental storehouses, 12 divisional storehouses, a remount depot of 62 buildings with provision for 6 000 horses, 331 stables, wagon sheds and shops, guard houses, fire stations, a bakery with capacity of 40 000 loaves per day, a refrigerating plant of 20 tons capacity per day, a laundry collection building, a post-office, a telephone and telegraph building, a library building, a garbage transfer station and incinerator, 5 garages, 4 magazine buildings, 13 Y. M. C. A. and 3 Knights of Columbus buildings, the Hostess House of the Y. W. C. A., a Y. M. C. A. auditorium with capacity for 3 000 people, 2 theaters, one with seating capacity of 3 000, 11 post exchanges, and a base hospital of 60 buildings connected by glazed corridors 1¼ miles in length.

A total of about 44 000 000 ft. of lumber was used — in great part of northern spruce — in order to avoid the railroad congestion which was most pronounced on the railroads to the south. Some 4 miles of railroad track were laid for the receipt and handling of material, and 20 motor- and gasoline-driven sawmills were erected along a side track, by which the lumber was sawed to dimension, marked for its place in the work, and thence carted by truck or motor — there were 125 trucks and 200 teams — to the proper building. An average of 500 000 ft. of lumber per day was in this way handled, and an average of 45 carloads of all material was received daily between July 1 and September 1.

Electric Light and Power.

Electric energy for light and power is purchased from the New England Power Company and furnished from hydro-electric stations of 62 000 K.V.A. capacity, located at Vernon, Vt., and Shelburne Falls — these stations being interconnected by complete double circuits. For the supply of Camp Devens two separate pole lines, on private right-of-way, each carrying a 3-phase 66 000-volt line, were run from the camp to Leominster,— a distance of 8.2 miles, — where the circuit of the power company was tapped. No. 2 copper wire, supported by 4-disk suspended insulators from steel cross-arms on wooden poles, is the type of construction. Just outside the cantonment a stepdown substation was located. The high-tension equipment is of the outdoor type and includes two main-line oil switches, one complete set of electrolytic lightning arresters, and an integral high-tension metering unit. Three 500 K.V.A. water-cooled transformers, with voltage ratio of 66 000 to 2 200, are placed in a small asbestos, metal-covered building. The operating building is a brick structure and contains a 10-panel switchboard and all low-tension apparatus. Outgoing lines are provided with disconnecting switches, choke coils, and lightning arresters. Provision was made for the installation of potential regulators in all lighting feeders, but these have not proved necessary and have not been installed.

The substation was constructed by The Power Construction Company under a subcontract, and great credit is due President Geo. W. Bunnell (now Colonel 101st Engineers) and Mr. C. R. Oliver, electrical engineer of the company, for good work quickly done. The first requisition of material was made on July 18, and thirty-two days later the station was carrying load. Much of the material — as is true of a great part of the 135 miles of wire used in the camp — was shipped by express.

The primary circuits from the substation are 3-phase 2 200-volt, installed on the loop system — pole line oil switches so dividing the circuits that with the exception of the sewage pumping-station feeder, any section, in case of fire or other emergency, can be cut out and energy furnished through other paths, thus making it unnecessary under any conditions to leave any large portion of the camp without current.

The secondary distribution is 110–220 volts, 3-wire, single-phase, — except for power services, — reduced from the primary voltage of 2 200 by 125 distribution transformers, which are protected by two lightning arresters on the primary side, these arresters being grounded to galvanized-iron pipe sunk 15 ft. into the ground. There is no secondary network — the secondaries on each side street being entirely separate from any other part of the system.

The street lighting system consists of three hundred 6.6 ampere, series, incandescent, gas-filled lamps of 100 candle-power each, controlled by a single 3-phase feeder from the station, with 3–10 kw. constant current transformers, each feeding one third of the camp, connected through pole line oil switches. The house services in the majority of the buildings are 3-wire 110–220 volts; in the case of stables and small buildings, 2-wire 110 volts. All interior wiring is concealed back of wallboard, knob and tube construction, run in accordance with plans furnished from Washington.

The standard lamp is a 50-watt, 113-volt Mazda lamp, the typical fixture having a drop cord, and socket with conical tin shade.

The power service includes that for the main water pumping and booster station and for the sewage pumping station. The primary voltage of 2 200 volts is carried to these points — the transformers at the main water-works stations being so tapped as to yield both 440 and 550 volts in accordance with the requirements of the pump motors.

The estimated load was 1 200 kw., and the annual energy demand 2 000 000 kw. hours.

HEATING.

All infantry and artillery regimental units are heated by steam from central plants; all officers' quarters and medical buildings in other units are heated from individual steam plants; all other buildings are heated by stoves.

A total of 507 buildings — in addition to the hospital — are steam-heated, this requiring thirteen central plants — ten with ten 67-h.p. boilers and three with seven 67-h.p. boilers, and 43 small individual plants — the total horse-power, exclusive of the hospital, being 9 927. These boilers are all of the cast-iron sectional type — the use of this type in the central plants being due to the difficulty of obtaining steel boilers in the allotted time. At the base hospital ten horizontal tubular boilers of 150 h.p. each were originally installed, and two more have since been added.

The steam is distributed from the central plants to the different buildings through overhead mains supported from small telegraph poles by iron brackets and adjustable hangers, a total length of outside lines — 2-in. to 10-in. diameter — of 8 miles being required. The mains were anchored to the buildings, the pole bracket hangers providing for intermediate expansion.

No return system was provided, and all condensation was discharged through traps in the different buildings, and wasted into the ground outside. Recently, provision has been made for the return to the boilers of the condensation at the hospital.

Outside mains were covered with 4-ply asbestos air cell, two layers of sea-weed quilt and a layer of waterproof paper. Mains inside of buildings were not covered.

The system within the buildings includes distributing mains near the ceiling, drop pipes, with single connection to bottom of radiators, extending down to the return mains which lead to the traps through which the condensation is discharged outside the buildings. Radiation in barracks is in the proportion of one square foot to fifty cubic feet, and was calculated to furnish a temperature of 60 degrees in extreme weather.

A fourteen-hour test, from 5 A.M. to 7 P.M., of one central heating-plant, was made on November 27, 1917, with measurements of coal and water used and observations of outside and interior air temperature and steam temperature at different points in the distributing system. The results showed that with an average outside temperature of 18 degrees on the north side of buildings, and with an average boiler pressure of less than 7 lb., the middle barracks in a day of light winds could be heated to 80 degrees and the most distant buildings to a temperature of 78 degrees.

From this it was concluded that with the heating system the temperature of buildings could be maintained at 60 degrees, with an outside temperature of 10 degrees below zero.

This test was made at a time when the operators had not become accustomed to the firing of anthracite coal, and the evaporation was low, being only 6.0 lb. per pound of coal burned. Later, by the excellent work of Major E. W. Briggs and his assistants in the Utilities Department, much better results have been obtained. In particular, the area of grates has been reduced one third, thicker fires carried and the dampers better handled. In January, February, and March the actual evaporation of the thirteen central plants averaged 7.5 lb. of water per pound of coal burned.

The traps, of which there are 2 500 in the cantonment, are the weak points in the system. In the early days the rust and scale in the pipes continually clogged the small discharge openings, and constant, untiring inspection, disconnection, and cleaning is necessary to keep the traps in effective operation so as to prevent freezing.

The regulation of the amount of steam admitted to each barracks from the common main so as not unduly to heat those buildings nearest the central plant at the expense of the more distant, requires careful adjustment of the hand-operated control valves and constant watchfulness is necessary to prevent tampering, with these valves.

The waste of the condensation with the consequent demands on the water supply and coal pile might, at first thought, be criticized, but the validity of such criticism depends entirely on the number of years the camp is to be used during the winter months, and, so far as now appears, the omission of a return system was good engineering.

The steam installation was proved capable, during the unusually severe winter of 1917–18, of heating the buildings thus supplied to the temperatures contemplated in the design of the system.

It is also true that stoves proved apparently satisfactory to those occupying the buildings so heated. The sociability of a red-hot stove presumably makes up for the greater uniformity of temperatures provided by steam.

Roads.

The roads were not included in the general contract of Fred T. Ley & Co., this work being awarded to the Barrett Manufacturing Company of Boston.

The general contractor was, however, required to construct such temporary roads as were necessary for the transportation of some 3 000 carloads of building material. As these roads were in almost all cases on the location of the permanent highways, to avoid the confusion which might result from two contractors on the ground, and in order that the permanent roads might be turned over to the military authorities without the wear incident to the construction of the camp, the road contract was not let until August and was not completed until November.

The road system includes three types or classes of construction. The first class is limited to the outside belt road which encircles the camp, and is the main artery for the transportation of supplies from the divisional to the regimental storehouse and for general traffic. This road has a 6-in. Telford base of local field stone, — a 2-in. course of No. 1 crushed trap, bound by 1½ gal. per square yard of high-carbon tar-penetration method, a thin covering of No. 2 trap sufficient to fill the voids and bound by one-half gallon per square yard of tar, a covering of pea stone, and a final application of one-quarter gallon of Tarvia B. No gravel or rocks suitable for crushing and use in the surfacing of first-class roads were found in the reservation, the crushed stone being brought in by railroad. The first-class roads have a width of 18 ft. of finished surface, with 6 ft. shoulders on either side. The total length is 6.90 miles.

The second-class roads are those forming the inner belt line which encircles the camp. These have a total length of 6.16 miles and are constructed of local run-of-bank gravel in two 4-in. layers, the top layer being water-bound.

The third-class roads are those which cross-connect the first- and second-class roads, and provide access to the kitchen end of barracks. The total length is 5.95 miles, and the construction of water-bound, rolled, run-of-bank, local gravel.

SEWERAGE AND SEWAGE DISPOSAL.

The sewerage system is designed for the removal of house sewage only, the connections being with the lavatories and with the kitchens of barracks.

The layout of the collecting system at Ayer is most irregular, owing to the broken topography, — the sewers being located to obtain the least cut without regard to the roadways. The main sewer follows the valley of Willow Brook and thence along the bank of the Nashua River to a pump well, located about a mile below the northern limits of the camp. Including the hospital and remount station, the total length of sewers laid was 13 miles, and of 6-in. connections to buildings, 10 miles.

The work was done in about fifty days, with an average rate of construction, for thirty-five days, of 3 100 ft. per day and 6 800 ft. as a maximum day's work. The average cut was 6.0 ft.; the maximum cut, 18.5 ft. Rock was encountered in a number of sections, and water and quicksand found along the main sewer. About 25 per cent. of the trenches required close sheeting, and about 25 per cent. of the excavation was done by trench machines. The joints in the main sewer are for the greater part of its length made with bituminous compound.

Vitrified clay grease-traps, 18 in. in diameter and with a capacity below the flow line of 13.2 gal., were placed on the majority of the kitchen connections. For the remainder, concrete box traps 3 ft. long by 2 ft. wide, with a capacity of 60 gal. below the flow line and with two wooden baffles, were constructed in place.

The vitrified traps are of practically no value in holding grease; the concrete traps are better, and retain enough grease to make skimming profitable, but a large part of the grease passes through, a fact made evident by the 15 tons of material — 63.5 per cent. fats in dry sample — removed on October 7, 1918, from the walls of the main pump well. Evidently larger and better designed traps are necessary to intercept grease from a camp kitchen so that it may be collected for its value. On the other hand, no stoppages have occurred in the lateral or main sewers, and none in the connections with concrete traps. About four per month on the connections with vitrified traps are recorded, but these are due in many cases to pieces of meat thrown into the trap. Aside from the question of making possible the collection of the grease before its mixture with the sewage, a large grease trap on the main sewer would most effectively protect the filters.

Instructions furnished from Washington required that sewers, flowing full, be provided for maximum discharges of seven times the average flow in the case of single regimental units, to 2.85 times the average flow from the entire camp, the averages being based on the contributing population at 55 gal. per capita per day.

The actual flow for the week of August 18 to 24 — which illustrates maximum conditions as recorded — is shown in a diagram herewith presented. With an average population for the week of 44 580, and an average water consumption of 49.0 gal. per capita per day, the average sewage flow is 39.3 gal. per day per capita; the flow on Friday is 125 per cent. of the average day; the flow of the maximum hour on Friday is 185 per cent. of the average for that day, or 231 per cent. of average for week, and the maximum flow for fifteen minutes is 251 per cent. of the average for the week.

The Nashua River into which the sewage of the camp or the effluent from treatment works must flow has a total watershed of 420 square miles at Ayer. Of this area 118 sq. miles are preëmpted for the Metropolitan Water Supply, and the run-off diverted. To the dry-weather flow, available for the dilution of sewage from the cantonment not more than 300 sq. miles could be assumed to be contributory and for a considerable period the dry-weather flow might well be less than 100 sec.-ft. or sufficient for the adequate dilution of the sewage of not more than 20 000 people. Further, in the watershed of 300 sq. miles there is a population of 70 000 people, and only the city of Fitchburg has disposal works. The river as it reached the site of the camp was already highly polluted, and the State Department of Health had already taken steps toward the betterment of the stream conditions. There could be no question as to the necessity for treatment of the sewage, and such treatment as would involve some form of filters.

It was not possible to apply the sewage to any type of filter without pumping, and the solution of the disposal problem lay either in the use of settling tanks and some type of rapid filter in the valley, reached by low-lift pumping apparatus, or the conding Aug. 24,1918.

amp system (approx.
systems.

r heating, sub station
kery, quartermaster's
qs, and numerous small
,000 gallons daily.

Base Hospital Flow

(Not Including Convalescent wards)

Date	Population	Sewage total
18	1993	110,000
19	1964	129,500
20	1876	138,000
21	1934	135,500
22	1909	146,500
23	1917	150,000
24	2014	137,000

Max. hour 1.75 to 2.35 times average
Min. " 0.35 to 0.40 " "

struction of intermittent filters of sand in natural position, 80 ft. above the river. The latter method was chosen, and 20 acres of filters were prepared by stripping off the top soil and using it to form embankments. The distribution of the sewage is similar to that in other Massachusetts plants, but there are no underdrains; the depth of the sand to the water table — in excess of 12 ft. — and the elevation of the area above the adjacent river making artificial drainage unnecessary.

The gravity outfall sewer ends at the pump well, — a covered circular tank of concrete of 150 000 gal. capacity. The entering sewage is screened through bar screens of ⅝-in. clear opening — smaller than general practice — to reduce liability of pump clogging to a minimum. An agitator consisting of an octagonal ring of 6-in. cast-iron pipe placed midway of radius of tank, tapped by 32 ¾-in. nozzles, and connected with the force main, was provided for the removal of any sludge deposits. Its use has been found unnecessary, as the floor slope of 1½ ft. in radius of 30 ft. and the course of the entering sewage keeps the floor free from sludge deposit.

To prevent floating of the tank by a rise of the ground water during extremely high stages of the river, a 4-in. vitrified pipe, laid in screened ground around the outside of tank at an elevation 5 ft. above the bottom was connected with inside of tank, with check valves opening inwardly.

The sewage is raised to the filters by a centrifugal pump of 2 800 gal. per min. capacity driven by 100 h.p. motor. The force main is of 16- and 20-in. cast-iron pipe, 2 355 ft. long.

WATER SUPPLY.

The general specifications, furnished from Washington, required a supply of at least 55 gal. per day for each man in the cantonment; this including an allowance for animals and being based on 50 gal. per man and 15 gal. per horse or mule. It was further specified that through storage or otherwise, provision must be made for a maximum demand of 2.85 times the average rate, for a period of one hour.

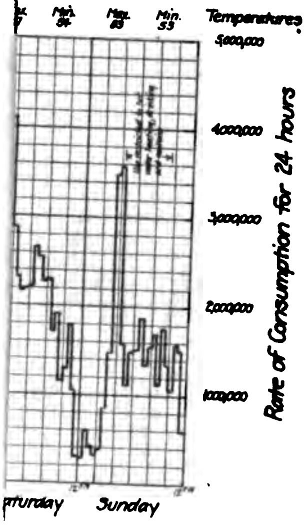
These estimated requirements of a semi-permanent cantonment, equipped with sanitary conveniences on a scale never before attempted, were necessarily made without the aid of recorded experiences under similar conditions. European allowances had ranged from 6.5 gal. by the French, 8¾ gal. by the Austrians, 11 gal. by the Germans to 20 gal. by the British, but for no such number and nearness of fixtures as were contemplated for the cantonments.

The actual record of the use of water, and a brief analysis of the results at Camp Devens, may therefore be of some interest. On one of the diagrams herewith presented there is shown the gross consumption, the consumption per capita, the population and the mean temperature for each week from October, 1917, to August, 1918. It is at once apparent that the varying population, which ranged from 20 000 to 45 000 men, and the demand for steam heating, are controlling factors in affecting the per capita use, which varies from 39.3 gal. per day in June to 81.5 gal. per day in January. The higher demand with reduced population is due to loss by leakage and to uses which are more or less constant and independent of population.

The water used for steam as measured by meters on all central heating plants from January to April was as follows:

	Gal. per Day.		Gal. per Day.
January	676 000	March	343 000
February	491 000	April	242 500

Other fairly constant uses and losses may be estimated as follows: Leakage from mains, services, and fixtures, 200 000 gal. per day; animals, 100 000 gal.; pumping stations transformers, garbage station, etc., 20 000 gal.; steam for hot water in summer, 75 000 gal.; and the gross requirements, more or less independent of population, have ranged from 400 000 gal. per day in summer to 1 000 000 gal. per day in the month of extreme low temperature. If the amount so used for each month is deducted from the gross consumption, the balance, or the water directly dependent on population, is found to vary from approximately 30 gal. per capita per day in the spring months to 40 gal. per day in the hot months of the summer. Also it appears that, if the population had remained constant at 40 000 men, the gross consumption would



-19, 1918

ENS-AYER, MASS.
TER SUPPLY—
WATER CONSUMPTION

have ranged from 40 gal. per capita per day in the spring months to 65 gal. per capita per day in the month of extreme low temperature.

A diagram, herewith shown, of the consumption during a week in May best indicates, by the minimum night demand, the rate of leakage from mains, services, and fixtures. Another diagram shows the hourly variation during hot weather and in December when the steam requirement is the controlling factor.

To what extent the consumption at Camp Devens might be further reduced by more stringent regulation cannot be stated, but the relatively low use of water during the past summer has only been reached by the strenuous effort of the officer in charge of utilities. Self-closing faucets and wash basins for each man instead of a continuous stream while standing at the lavatory, faucets to supply hot water and thus do away with the temptation to use the shower-heads too frequently, and automatic valves to reduce the pressure in the lower areas of the camp, would all effect a saving of water, but would involve increased cost and difficulty in obtaining fixtures. The ingenious insertion by the Utilities Department of lead plugs ½ in. long, tapered from ⅝ to ⅜ in., tapped by ⅛-in. hole, just back of the faucets in the service pipes of the high-pressure area resulted in a substantial reduction in consumption, as has also the decreasing of the depth of water in the flush-closet tanks.

The use of water has been greatest on Friday, and exceeds the average for the week by about 10 per cent. The consumption during the maximum hour, which occurs in the early morning, is not of importance in determining the storage to be provided. The curves of hourly use at Camp Devens indicate a consumption for seventeen hours in excess of the average daily rate, and, on the assumption that the pump will operate at the average daily rate of consumption, it appears from the curves above referred to that, without allowance for fire service or any reserve, the storage necessary to meet the deficiency during these seventeen hours ranges from 20 to 25 per cent. of the total daily consumption during the summer months and from 10 to 15 per cent. during the winter months. Unless the rate of supply is made to vary to a greater or less degree with the hourly use, a storage of at least

25 per cent. of the maximum summer consumption plus that for fire service should be provided.

The supply is obtained from the ground near the shore of Grove Pond. The town of Ayer had for years been taking somewhat less than 200 000 gal. per day from 28 2½-in. wells located near this pond. Between June 1 and 20, 1917, the Preliminary Board of Engineers, assisted by Mr. W. S. Johnson, made a ten-day test run at a rate of 1 000 000 per twenty-four hours — indicator wells having been driven in various directions to show the effect of this rate on the adjacent water table. The resulting small depression of the ground water and the proof that a draft of 800 000 gal. per day could be maintained from the Ayer wells was taken as good evidence of the ability of the well field to furnish a supply of 2 000 000 gal. daily to the cantonment and also that from the Ayer system 250 000 to 500 000 gal. per day might be obtained as a temporary supply during construction. From the evidence of numerous test wells it was decided to excavate a well 50 ft. in diameter and 30 ft. deep at a point about 1 000 ft. east of the Boston & Maine Railroad and about 100 ft. from the shore line of the pond. A report of the Preliminary Board of Engineers to Brigadier-General Littell, dated June 21, 1917, reads that " it is believed that this well will furnish 1 500 000 gal. per day and perhaps more," and that if its capacity as determined by pumping during construction and by observation of water-table depression should prove less than 2 000 000 gal. per day, " 2½-in. wells can be driven along the shore of the pond and arranged to siphon into the excavated well." This anticipation of the possible necessity of auxiliary driven wells proved true, for, while the pumping during construction indicated an available supply exceeding that required by the cantonment, the quantity which could be continuously drafted without lowering the water to a level dangerously near the bottom of the suction pipe was found after several months' use to be about 1 750 000 gal. per day. This was due in part to the fact that in the excavation of the well the bottom " blew up," carrying from lower depths large quantities of fine sand and thus sealing the bottom area to a certain extent and making the available draft dependent in great part on the water entering through the sides. The well was constructed by driving vertical wooden

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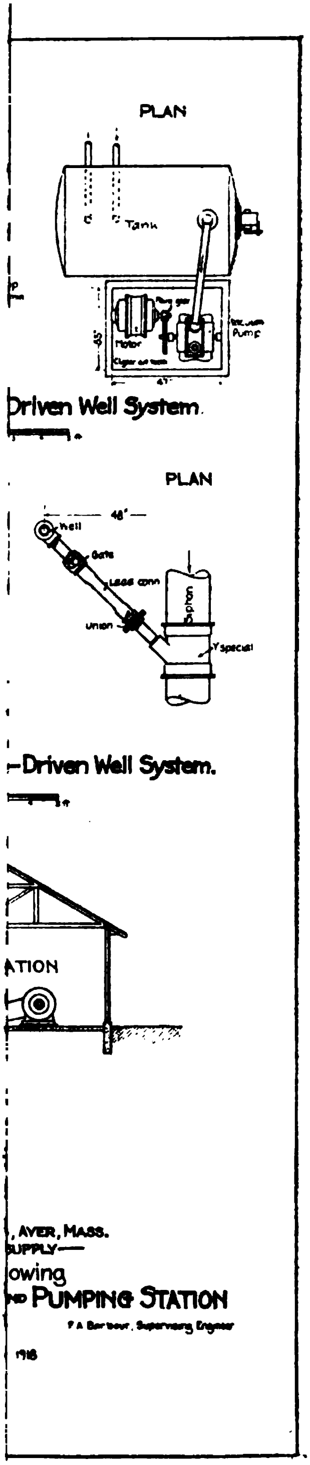

sheeting in three sets back of circular ribs, this sheeting forming the permanent sides and no masonry being provided.

Observations of the elevation of the water table in test wells adjacent to the dug well established the fact that, while from the well less than 2 000 000 gal. per day were obtainable, there was ample supply in the adjacent well field, the water standing 8 ft. higher in the ground 50 ft. from the well than in the well when pumping at a rate of 2 000 000 gal. per day. Accordingly, the driving of 2½-in. wells was recommended on September 20, 1917, and these have since been provided although not available for use until June, 1918.

The method of hitching up these driven wells with the main supply may be of some interest. This is illustrated by a plan herewith presented and involves the carrying of the main suction pipe, to which the 40 wells are connected in the ordinary way, on a flat rising gradient to a point near the main well, from which point it turns down into the well so as to form a siphon. From the top of this suction pipe at the high point, two lines of 2½-in. pipes connect with a steel tank 4 ft. in diameter, 6 ft. long, and of 75 cu. ft. capacity — one line ending at the bottom of this tank and the other extending through the bottom and well towards the top. From the top of the tank a 2-in. pipe, rising to a height sufficient to prevent water being drawn over, connects with a rotary dry vacuum pump of 70 cu. ft. per minute air capacity driven by a 7.5 h.p. motor. The pump creates a vacuum in the siphon line and starts the flow of water from the driven wells to the main well at a rate dependent on the difference in level of the water in the driven wells and in the main well, and it also fills the tank with water. As air is released in the suction or siphon line it flows to the tank through the 2½-in. pipe which extends to the top of tank — the displaced water returning to the suction line by the other 2½-in. line. The tank thus provides storage for air outside of the siphon line which remains in continuous operation. When an alarm operated by float in tank indicates that the tank is full of air, the vacuum pump is again started, from one to two runs of a few minutes each being necessary daily.

To insure air-tightness in the siphon line each pipe and fitting was submerged in water and subjected to 100 lb. air pressure before being laid. About twelve lengths of pipe and several fittings, which by customary methods would pass inspection, were found to leak air — the leakage being always through the bells of the pipe and the top of fittings as cast. After laying, an air pressure of 50 lb. was applied to the suction line and all joints, which were made with a 3-in. depth of lead, and which had been covered for the test by a mixture of soap and water, were examined and recalked where necessary. It is believed that the test of individual pipe might safely have been omitted.

The supply has been more than ample for all requirements since the installation of the driven wells and the source, as now developed, is probably capable of furnishing 300 000 gal. per day.

The water has been of excellent quality, soft, free of metallic contents, cold in summer — maximum temperature about 52 degrees — and relatively warm in winter.

The pumping station is a wooden building and contains the transformers, switches, motors, and pumps. Two pumping units — one direct and one belt driven and each of 2 000 000 gal. per day capacity against a head of 250 ft. — were first installed; recently a third unit of the same capacity has been added.

From the pumping station two lines of 12-in. wood-stave pipe, each 6 175 ft. long, laid 40 ft. apart, lead to the cantonment. A Venturi meter records the amount pumped.

The distribution system follows, in general, the typical layout furnished from Washington, and comprises double loops of 8-in. wood-stave pipe, 500 ft. apart and located between and parallel to the main inside and outside circulating roads. These lines are connected to the storage tanks by two lines of 10-in. pipe; an 8-in. loop extends around the divisional storehouses, two 10-in. lines lead to the hospital, and an 8-in. line to the remount station.

The total length of pipe — 4–12 in. in diameter — is 20.8 miles, of which 17.9 miles are of wood stave. In addition there are 17.8 miles of services ($\frac{3}{4}$ to 2 in.) of galvanized iron. Gate valves number 122, and 4-in. hydrants, 418.

The stave pipe used is redwood, as are also the storage tanks. The pipes are machine-banded by spirally wound galvanized wire, with tenoned ends to fit wooden connecting collars which are also wire bound. Cast-iron fittings were used for hydrants, branches,

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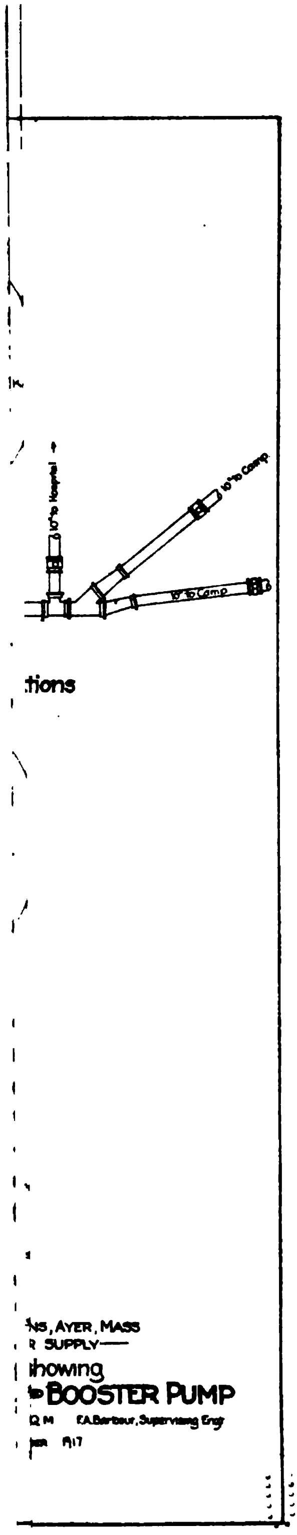
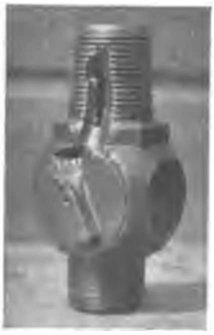


and sharp angles. Repeated attempts in the presence of a representative of the wood-pipe manufacturer proved that it was impossible to make tight joints between the wood pipe and the standard cast-iron fittings furnished, and it was necessary to obtain special nipples — with larger bells on one end — to connect the standard fittings and the wood pipe.

Wood-stave pipe instead of cast-iron was used in the cantonment because of the lower cost (which averaged about 42 per cent. of that of iron at the time of purchase) and because it could be quickly obtained.

Does the experience with wood-stave pipe in this camp work suggest a more frequent use of this material in general water-works practice, is a question which it may not be out of place to briefly consider. Of course the answer must primarily rest on the first cost of wood as compared to iron pipe and on the probable life of wood pipe, which depends on the life of the wire bands, and this in turn on the quality of the soil in which the pipe is laid. Under normal market conditions, wood pipe will not be relatively so cheap as in 1917, and as to the life of machine-banded spirally wound pipe the answer cannot be supplied by the brief experience in the cantonments. Undoubtedly its life, as determined by that of the bands, is but a fraction of that of cast iron, and it cannot supply the assured permanence which is so important a factor in a system to be laid under the paved streets of a city or town where first cost is not the controlling element. It has greater discharge capacity than iron, and it can be more quickly and cheaply laid and repaired. Service connections are easily made by corporation cocks screwed into the wood. As indicated by results at Camp Devens, the leakage — apparently less than 100 000 gal. per day from 18 miles of mains — is not excessive. Spirally wound pipes are open to the objection that, if the wire is cut at one point, the resistance to bursting pressures for the entire length is gone; with the circular metal bands used with continuous stave pipe in larger sizes there is more metal to resist corrosion or cutting and the loss of one band does not necessarily seriously damage the pipe. Several cases of bursting pipes have occurred at Camp Devens, caused by cutting of the spiral wire by fine jet leaks and the erosion of sharp sand. As an illustration of this eroding power, a heavy brass corporation cock screwed into the wood was worn through in less than ten days, as shown in photograph herewith presented.

At Camp Devens the pipes were laid so as to obtain a uniform cover of 5 ft. measured from the original surface of the ground. Subsequently the grading operations carried on by the soldiers in smoothing up around the barracks materially reduced this depth in a number of places, and picks were driven through the shell of the wood pipe. Such incidents, however, are of minor importance and would not occur in ordinary municipal work, and in general it may be said that the wood-stave pipe to date has proved very satisfactory.



The shorter life of wood-stave pipe as compared with cast iron and the necessarily earlier derangement of connections and street surfaces incident to replacement of the system are the important considerations in determining the choice of material rather than the failure of wood pipe to meet necessary requirements during its life — whatever this period may be.

Where first cost is not the determining factor, and in cities and towns with complicated distribution systems and paved streets, wood pipe certainly cannot be justified; but for small communities where first cost is all important, for cross-country lines when a reasonable assumption of the life of wood pipe shows its use to be economically justifiable and for extensions to outlying districts — such as are now generally made with wrought iron of insufficient size to supply hydrants — it would seem that wood-stave pipe is worthy of more consideration than it has been accorded in the past.

The writer is likewise impressed with the possibilities of wood-stave tanks — not as a comparable alternative to steel or concrete but as a means of providing storage in cases where first cost is the all-controlling element. At Camp Devens four redwood stave tanks, 30 ft. in diameter and 20 ft. deep, of 100 000 gal. capacity each, supported on wooden towers 26 ft. high, were erected on ground at elevation 381.0 near the southern end of the camp. The ground surface in the camp varies from elevation 250 to elevation 350, and the static pressure with tanks half full ranges from 30 lb. to 75 lb. To provide greater pressure for fire service in the higher area, a booster pumping unit — consisting of 50 h.p. motor driving direct a 2 000 g.p.m. centrifugal pump, set in a 12-in. by-pass on the 16 main leading to the tanks, and located in a small frame building at the base of the tanks, was provided. By closing a valve on the main straightway connection to the tanks, water is drawn by this booster pump from storage, and the pressure raised 24 lb.

There are three fire stations in the cantonment equipped with light motor apparatus and numerous hand hose reels on wheels housed at various points. Several fires have occurred, but these have been held to the first building attacked — a result which speaks well for the efficiency of the fire department.

GARBAGE.

The garbage is hauled by the military establishment to a transfer station located in the extreme western corner of the camp, and from this point is taken by a contractor, who is paid a monthly sum for the removal and sanitary disposal of all wastes at a point not less than three miles from camp. A small incinerator was constructed at the transfer station, but has been used comparatively little.

The preceding description of Camp Devens will serve to illustrate the magnitude and the diversity of the work involved in the construction of the sixteen cantonments. It is not the story of any great engineering design, but rather of how much can be accomplished in a very short time, when emergency demands, by coöperation of all those engaged in the undertaking.

It tells of unusual ability, judgment, and courage on the part of those engineers at Cantonment Division Headquarters, who planned in a few weeks the general scheme and equipment of the cantonments and who so successfully drew the line between extravagance and the provision of the facilities necessary to the protection and physical betterment of the conscripted men. It describes the variety and bulk of the work done by the contractor through excellent organization and untiring energy, and, in its reference to operation, it calls attention to the success of Major E. W. Briggs who has had charge of the utilities.

A brief word of reference to the work of the Government engineering force in the building of the camp must be added. This force, which, including the inspectors, numbered at one time 125 men, worked at high pressure for long hours seven days each week with a spirit of service which has not been bettered by any organization.

Particularly to the men at the head of the several divisions of the engineering department is due whatever of the success at Camp Devens accrues to the Government engineering force on the ground, and the writer gratefully records his appreciation of the work done by Mr. H. J. Kellaway, general layout; Mr. E. G. Bradbury, sewerage and disposal; Mr. N. J. Neall and Mr. H. B. Abbott, electric light and power; the late Mr. W. S. Johnson, water supply; Mr. Geo. H. Wetherbee, general surveys and staking; Mr. C. W. Kimball and Mr. C. H. Bartlett, heating; Mr. W. S. Collins, roads; and by Mr. R. J. Fogg and Mr. E. K. Cortwright, inspection and reports.

THE SELECTION OF METERS.

BY CALEB MILLS SAVILLE.

[*November 13, 1918.*]

One of the ways that water departments are trying to meet and balance increased cost of labor and materials with available income is by close investigation of the necessities for purchase. In every branch of work, study is being made that will develop a proper solution of the problem of keeping service at a maximum with a minimum of expenditure. Many large ways of doing this are apparent, such as conservation of the coal pile, fewer main-pipe extensions, general installation of the meter system, and similar matters. Among the things perhaps less obviously important is the purchase of meters to meet individual requirements. The right answer to the question, what size of meter to install on a given water-service connection, is one well worth consideration.

On the one hand is the consumer, urged on by his plumber, clamoring for a large-sized meter in order to get a large flow of water with little loss of pressure. On the other hand is the water-department expenditure soaring higher and higher as the price of meters rises, due to increased cost of production.

In those cities where a service charge or a minimum rate is made dependent on the size of the service, the expense of installation is not so important as where no such charge is made.

Study of water-department reports indicates that the per capita requirement for water is increasing in this country as a legitimate result of more extended use, especially in larger places. For example, in a report to the Cambridge (Mass.) Water Board in 1903, page 18, the late Freeman C. Coffin stated, "The rate of increase in the consumption of water of 5.475 per cent. per year, or about 30 per cent. in five years, is higher than that of the increase in population, which is 13 per cent. in five years." In the

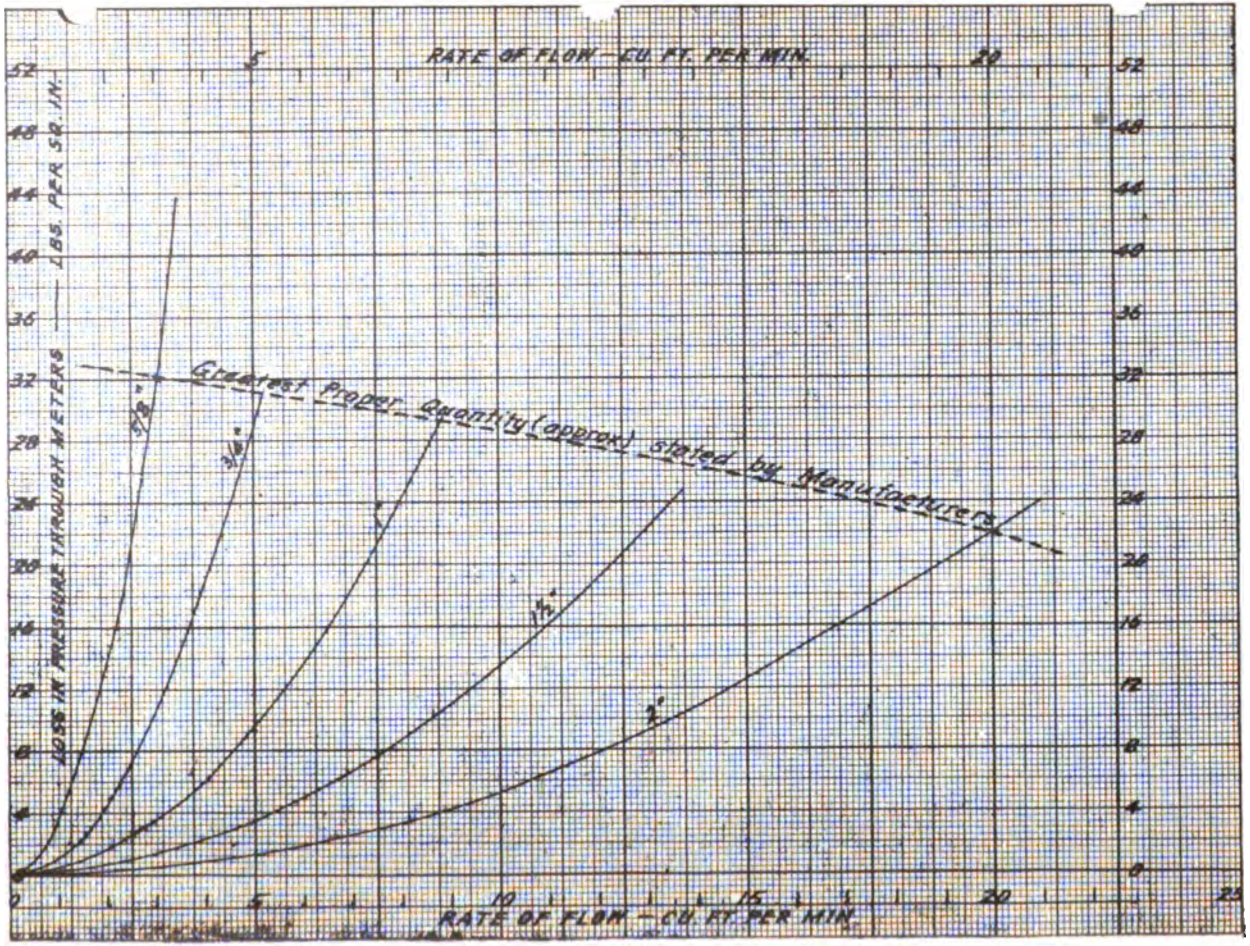


FIG. 1. AVERAGE LOSS OF HEAD IN DISK METERS OF DIFFERENT SIZES.

Freeman and Stearns report on the Baltimore Water Supply, 1910, page 24, it is stated that " there is a strong tendency manifest in nearly all the larger American cities for the per capita supply of water to increase from year to year "; and in the report on the increased water supply for the city of Providence, 1915, page 6, it is stated that " the city of Providence has for many years sold water on a metered basis, and the consumption per capita is low. It is, however, higher at the present time than it was ten or twenty years ago, the increase in per capita consumption being on an average about three quarters of a gallon daily per year." It appears, therefore, that besides the increase in total consumption to be expected as the number of people supplied becomes larger there is also a gradually increasing individual use of water. The general introduction of meters will help very materially in reducing waste, and thus aid in conserving water. The fact must not be lost sight of, however, that each place has its own characteristic, irreducible minimum, below which it is impracticable to reduce consumption and above which there is a constant tendency for proper increase.

This condition, so far as it relates to domestic use, may be due to several causes, among which are: First, plumbing installation in houses not previously having such conveniences; second, increase in the number of fixtures in houses already having plumbing fixtures; third, the installation of more modern plumbing devices which require water at high pressure and in comparatively large amounts for short periods. This last reason is of most interest in connection with the subject of this paper, because of its direct connection with the size of meter to be installed, the cost relative to the amount paid by the consumer, and the burden of the expense of installation and upkeep to the department. Advance in the plumbing art aims to control waste and to increase efficiency. The tendency in flushing is to produce a sudden deluge for a short period instead of the former lesser rate of discharge extending over a long period. For example, flushometer closets and urinals are very effective and usually economical in the total use of water. These fixtures, however, demand larger service pipes and meters than the older tank closet in order that the pressure and velocity of the flushing water may be as high as possible.

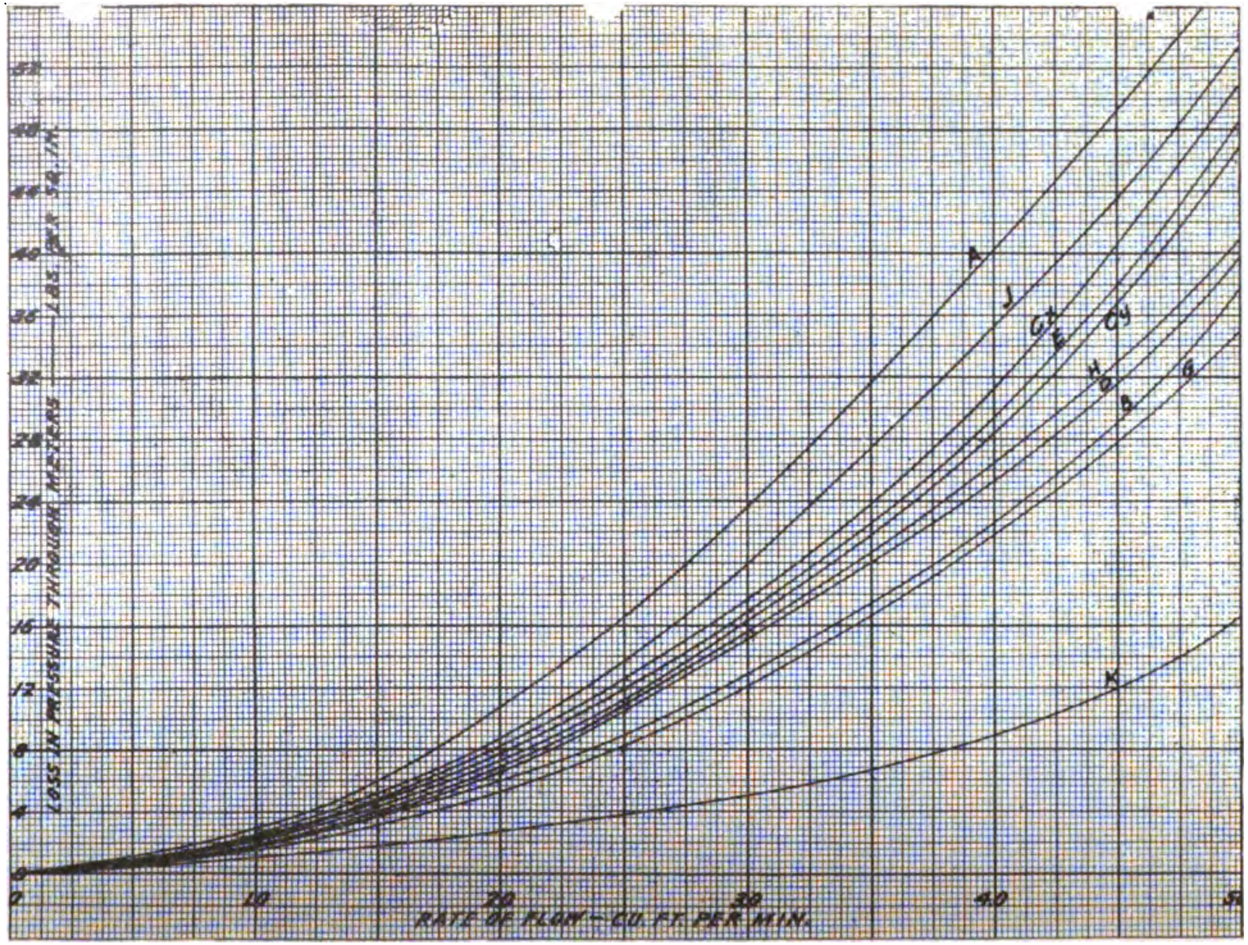


FIG. 2. LOSS OF HEAD IN ⅝-IN. DISK METERS OF VARIOUS MAKES.

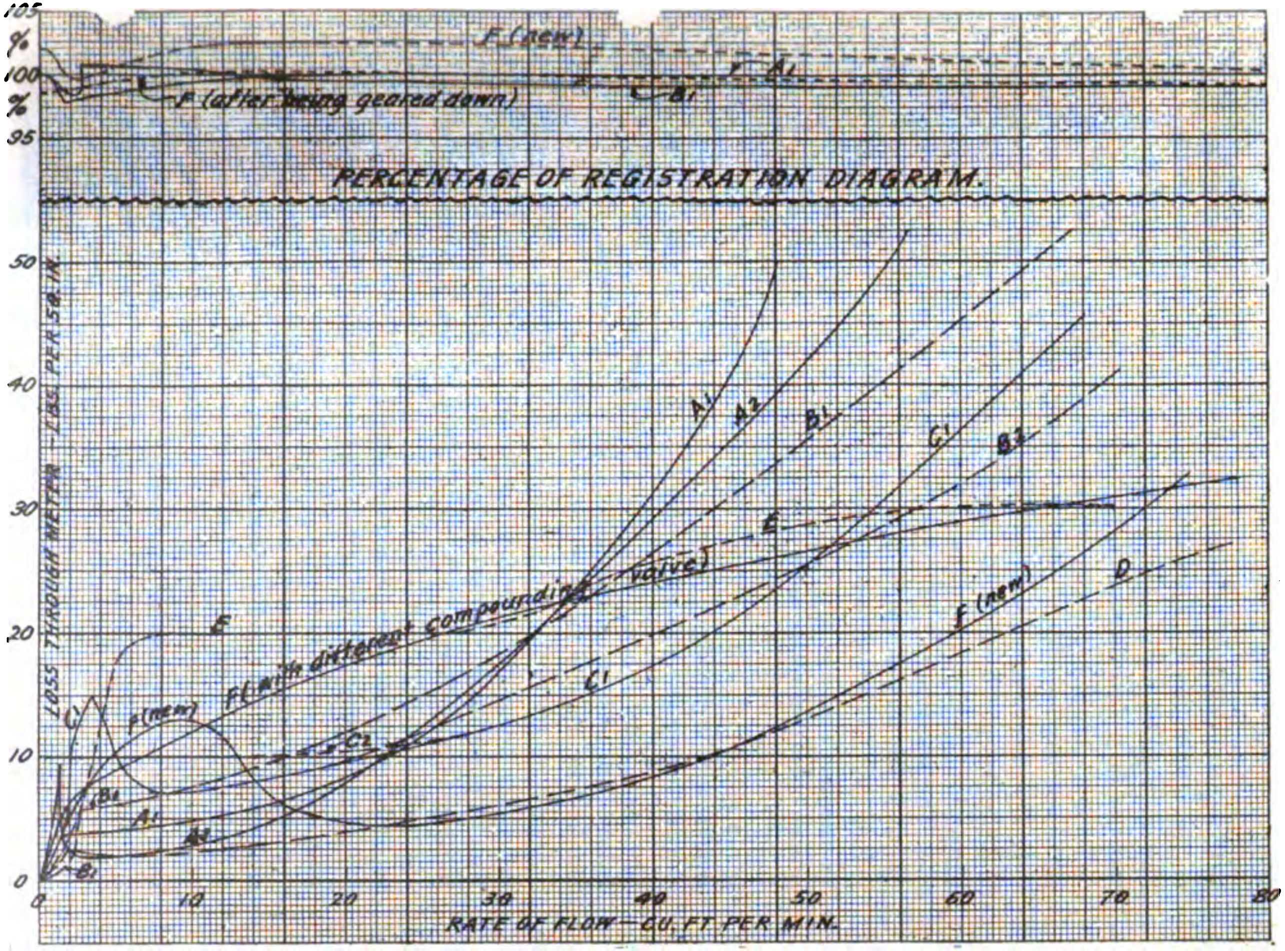


Fig. 3 Loss of Head in 3-in. Disk Meters of Various Makes.

The size of meter to be installed on a service is more dependent on the rate of flow required and the drop in pressure due to this flow in a given meter (Fig. 1) than on the actual quantity of water to be passed through it.

To meet these conditions with a view to economy as well as efficiency it is desirable to consider among other things:

1. The installation of larger service pipes instead of larger meters.
2. Proper provision in the house-piping system, to meet the demands of modern plumbing, instead of installing larger meters.
3. The selection of meters properly designed for the particular use to which they are to be put.

Requests for larger meters usually disclose that " my plumber advises me that the meter is too small and interferes with the proper operation of the new piping which has just been put in." In other cases it has been found that, although the interior piping is old and filled with rust, the owner has been advised that his trouble will be remedied if he gets a larger meter.

As to Item 2 above, it seems very probable that possibly a large-sized riser pipe acting as a house standpipe where flushometer fixtures are installed might give a better service than could be obtained by use of a larger meter.

Item 3 relates to the selection of meters, and the results of some investigations given below may be of interest if only as a suggestion of possibilities. So far as accuracy of registration and durbility goes there seems little to influence choice between any of the meters now put on the market by the half-dozen or more reputable manufacturers of water meters.

(On the diagrams referring to meter performance, letters designate different makes of meters.)

So far, however, as loss of head is concerned, meters of different makes now on the market show considerable variation.

This matter is an essential requirement, and it easily may be the case that a smaller meter of one make, and therefore of less cost, will do the work as efficiently as a larger and more costly meter of a different make. For example, the maximum proper rate of flow for 1-in. disk meters is about 8 cu. ft. per min. According to information furnished by manufacturers, one make of meter loses 19 lb. per sq. in. and another 31 lb. at this rate of discharge.

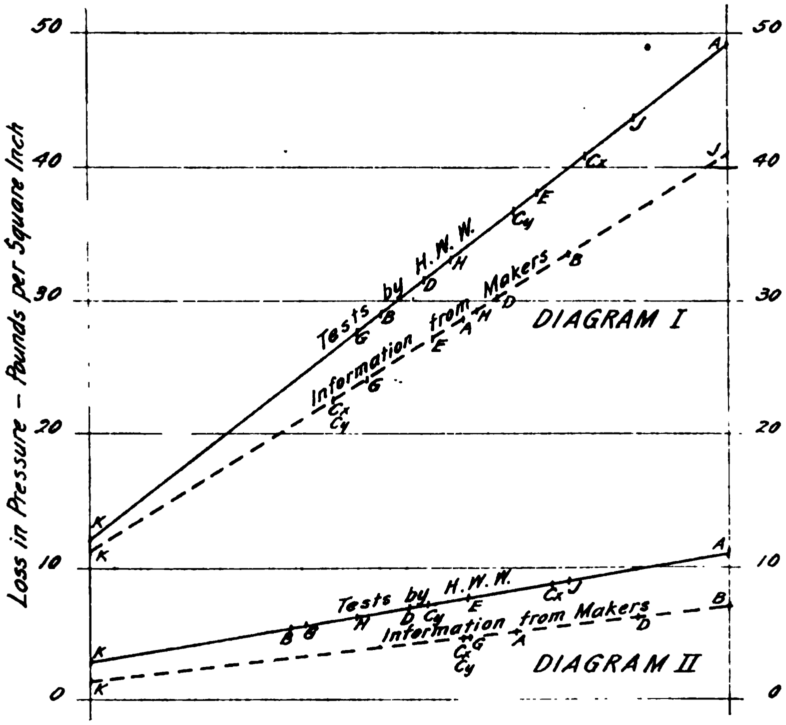


Diagram I. Rate of flow = 4.5 c.f.p.m. Diagram II. Rate of flow = 2.0 c.f.p.m.

FIG. 4. ¾-IN. DISK METERS.

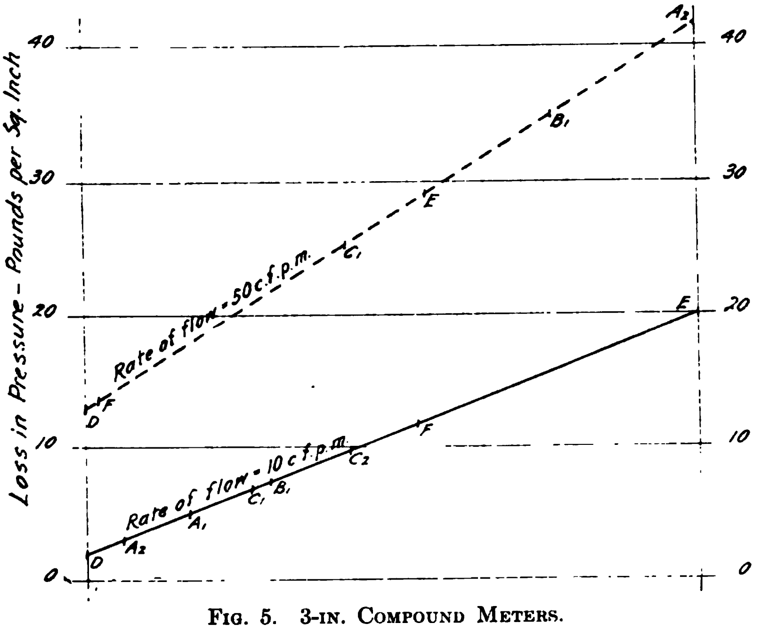


FIG. 5. 3-IN. COMPOUND METERS.

COMPARATIVE LOSS OF HEAD IN METERS OF VARIOUS MAKES.

If this flow were required with minimum loss of head, a 1-in. meter of the former make would do the work as well as a 1½-in. meter of the other make.

As a 1-in. meter, however, costs about twenty dollars, and a 1½-in. costs forty dollars, a saving of twenty dollars results, therefore, from careful selection among the different makes on the market.

The same reasoning applies also to choice of a compound meter. For example, suppose a flow of 48 cu. ft. per min. is required under conditions where loss of pressure is of moment. With a 3-in. meter of one make there is a loss of head of 12 lb. per sq. in., while with another make of the same size and similar flow the loss in pressure is 39 lb. per sq. in., or more than three times that of the former. In this case it is probable that if the latter make were used a 4-in. meter would be installed.

Three-in. compound meters cost about $160.00.

Four-in. compound meters cost about $260.00.

The saving by using the meters of former make would be one hundred dollars.

There are similar differences in loss of head in smaller-sized meters of different makes, and while the differences in cost between ⅝-in., ¾-in., and 1-in. meters are not as great individually as in the larger sizes, nevertheless more meters of these sizes are used, and the saving to the department is apparent whether it be an accumulation of several amounts or one lump sum. Beside the money saving, consumers are much better satisfied with service that gives them the best possible results in the operation of their modern plumbing fixtures.

In many cases maximum rates of flow occur only for short periods, and this phase of the matter also has considerable bearing in deciding the economical as well as most efficient size. Some of the rates of flow met with, in ordinary practice, in Hartford are given in the following tables:

TABLE 1.

SUMMARY OF OBSERVED RATES OF USE OF WATER AT VARIOUS BUILDINGS.

Board of Water Commissioners. City of Hartford. Engineering Department. February 29, 1916. Acc. 347.

Building.	Size and Make of Meter.	Fixtures Supplied.							
		Water Closets.	Urinals.	Wash-stands.	Slop Sinks.	Bath Tubs.	Shower Baths.	Drinking Fountains.	Hydraulic Lifts.
Pilgard.............	2-in. Trident	27*	10	47	5	5 Seldom used.			
Pilgard Market......	3-in. Trident								1
A. E. Burr School, Wethersfield Ave...	2-in. Trident	35*	22	10	3		10	11	
Hartford-Ætna National Bank....	2-in. Lambert								1
New Dom Hotel.....	1½-in. Empire	40‡		150		12			
New Dom Hotel, (for elevator).....	3-in. Crest								
Brown School, Market St........	2-in. Hersey	23‡	12	13	2			6	
20-Tenement Block, 150 Market St.....	1½-in. Thomson	20§			60	20			
G. Fox & Co., Main St..........	1½-in. Thomson	11‡ 12§	2	15	2			2	
Brown, Thomson & Co., Main St......	1½-in. Empire	19* 30‡	8 Seldom used.	29	22	20		2	
Empire Laundry, Sheldon St........	3-in. Hersey Compound	3*		3	8 washing machines — 150 shirt capacity 1 washing machine — 50 shirt capacity				

* Flushometer. ‡ High tank. § Low tank.

TABLE 1.—*Continued.*

Building.	Elevators.	Fixtures Supplied.		Max. Obs. Rates, C.F.P.M.		Meter Needed on This Supply.	Remarks.
		Fire Lines.	Miscellaneous.	Of at least 10 Cu. Ft. Continuously.	Of Small Quantity in Short Time.		
Pilgard............			2 small boilers (return feed).	7.0	..	1 in.	Meter changed to 1½ in., 56 rooms and 150 people regularly occupying same.
Pilgard Market....			1 small boiler.	3.3	20.	2 in.	Meter changed to 2 in.
A. E. Burr School, Wethersfield Ave.			2 138 H.P. boilers. 1 emerg. hyd. pump.	23.0† 12.0	20.	As installed.	About 460 pupils.
Hartford-Ætna National Bank...				12.0	18.	As installed.	Fixtures are supplied from tank on roof.
New Dom Hotel...				1.2	1.2	Not over ¾ in.	Meter changed to 1 in.
New Dom Hotel, (for elevator)...	1 pump-operated, but direct in emergency.			30.0	..	As installed.	

Brown School, Market St........			1 low-press boiler (return feed).	5.9	6.0	1 in.	About 500 pupils and 15 teachers, 10 rooms 31 ft. x 27 ft.
20-Tenement Block, 150 Market St....				1.2	Very slight.	Not over ¾ in.	About 110 people.
G. Fox & Co., Main St..........	1 (pump-operated)	1 ¾-in. conn. 1 1½-in. conn.	1 boiler (return feed).	3.0	4.3	As installed because of fire lines.	1,000 employees and several hundred customers per day.
Brown, Thomson & Co., Main St.....			1 soda fountain conn. 4 dentist's spittoons.	10.0	12.5	As installed.	60 two-room apartments occupied by 120 persons and department store.
Empire Laundry, Sheldon St........			1 250 H.P. low-press. return-feed boiler.	30.0‖	30.0	As installed.	

---

† Swimming pool being refilled.

‖ Of at least 100 cu. ft. continuously.

Of the eleven premises noted, changes in original installations were made in four, with no apparent detriment to the service, which resulted in a saving of first cost of about one hundred dollars.

During the past two years that this investigation has been going on, the saving in new and old installations is estimated to have totaled over one thousand dollars.

The following tables give rates of water actually observed in the operation of various fixtures using water.

Memo Re Rates of Use of Water by Various Plumbing Fixtures.

Fixtures.	Rate of Use. C.F.P.M.
1. Flushometer closets.	
Operating singly	4.5
Three operated in quick succession	10.0
2. Shower baths.	
10 continuously	6.0
5 continuously	4.0
10 continuously and four flushometer closets operated in quick succession	12.0
3. Urinals.	
22 operated in quick succession by two persons	5.0
4. Hydraulic lift at Hartford-Ætna National Bank	18.0
5. Hydraulic lift at Pilgard Market	20.0
6. 6-in. plunger hydraulic elevator	30.0
7. Washing machines.	
Filling two 150-shirt machines	30.0
Filling one large machine	17.0
8. Loomis and Manning filter at Hartford-Ætna National Bank	12.0
9. Filters at Alfred E. Burr School, limit of capacity	23.0
Washing filters	10.0

Very little information seems to be available in regard to rates of flow in service pipes and their duration, and no device was found on the market for getting an autographic record of the continuous use of water through service pipes and meters. Having had some experience with the Freiz Automatic Rainfall Register, the writer suggested to one of his assistants the possibility of adapting the recording mechanism of this machine to the required purpose. After some experimentation, Mr. J. E. Garratt, office engineer of the department's staff, made suitable electric connections between the meter-counter and a rain-gage recorder, and carried out, in an able manner, the fieldwork of investigation. The apparatus is rather clumsy to take about, but it answers the purpose very well, and from its record some very interesting facts have been learned regarding use and waste of water. The apparatus is carried in a box 18 x 18 x 20 in., and including box weighs about 40 lb. The instrument is crude and probably not extremely accurate; nevertheless the records are submitted at this time as an indication that may throw some light on the matter of water unaccounted for in systems where the services are very thoroughly metered. At any rate, the subject of meter accuracy of registration at low flows and the loss of head on high ones seems to be well worth careful study in the interests of economy, efficiency, and conservation.

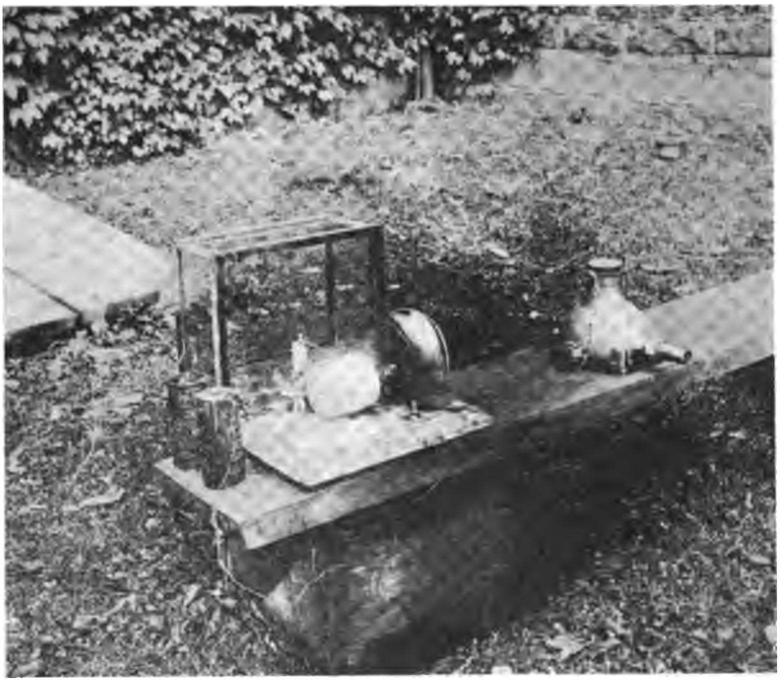


FIG. 6. RECORDING DEVICE ON ¾-IN. METER.

The registering apparatus consists of an eight-day clock with driving mechanism for rotating a cylinder about four inches in diameter, around which the chart is wrapped in one fold. A very ingenious device carrying the recording pen is operated by electric contact at each tip of the bucket in the rain gage or each revolu-

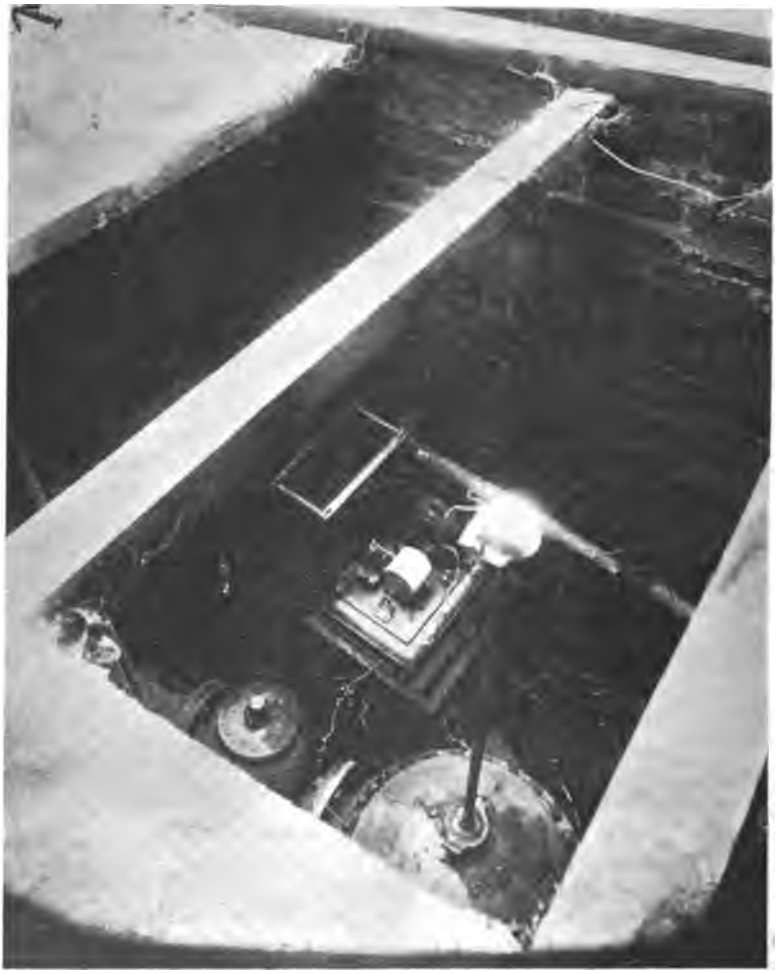
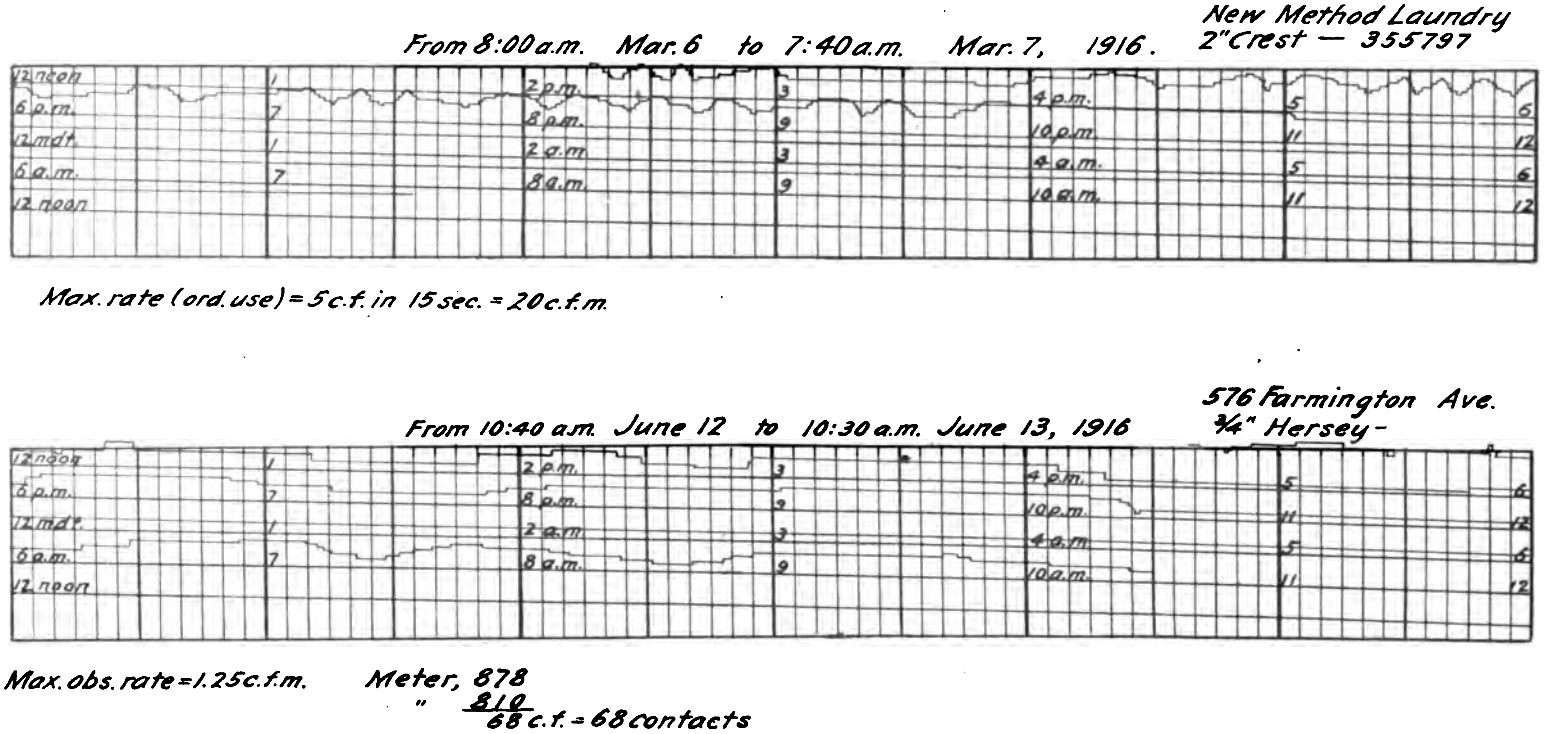


FIG. 7. RECORDING DEVICE ON LARGE METER IN PIT.

tion of a counter in the case of a meter. The driving mechanism is so constructed that the drum makes an entire revolution every six hours, and the feed is so regulated that the pen describes a spiral on the rotating chart, the lines of which are about one quarter inch apart, and thus avoid being superimposed. Rate of flow is indicated by the number of contacts registered by the pen on the chart, Fig. 8. Each of these contact marks is in the form of a step, the characteristic trace being five steps down and five steps up. From top to top of any series of steps there are 10 contacts. The chart is marked vertically in five-minute lines. At a glance, therefore, it is possible to read the number of steps or revolutions in any given period, and also observe the time at which the water was drawn. One defect in the registering device is its inability to record sudden flows of less than 1 cu. ft., although the total quantity is registered. For an example of the use of the recorder: on the 576 Farmington Avenue chart the record began about 10.40 A.M., Tuesday, June 12, and the preparations for luncheon are clearly shown. At 11.47 a draft of about 2.5 cu. ft. per min.; at 12 noon another draft of a similar amount. Throughout the afternoon there was some use up to about 3 P.M., then a period of comparative rest until about 6 P.M., when for two hours during the dinner period there was intermittent use. At about 10.25 a use of about 5 cu. ft. in four minutes indicates possibly the filling of a bathtub. From this time until 6.17 the next morning there was no flow, indicating either remarkably tight plumbing or a meter which failed to register small flows. From 7.10 to 8.50 a considerable use of water is noted, used probably for bathing and for the family breakfast. The maximum use in the house on this day was 1.25 cu. ft. per min., and it is noted that the recording mechanism checked the meter reading of 68 cu. ft. for the twenty-four hours' use. For the week that this house was under observation the following consumption and maximum rates were shown.



From 8:00 a.m. Mar. 6 to 7:40 a.m. Mar. 7, 1916.

New Method Laundry
2" Crest — 355797

Max. rate (ord. use) = 5 c.f. in 15 sec. = 20 c.f.m.

From 10:40 a.m. June 12 to 10:30 a.m. June 13, 1916

576 Farmington Ave.
¾" Hersey -

Max. obs. rate = 1.25 c.f.m.

Meter, 878
" 810
68 c.f. = 68 contacts

Fig. 8. Typical Chart from Recording Device.

In the following table, made up from the chart record of the same house, June 5 and 6, many interesting features appear which seem to be characteristic of this class of service. The rates of flow of this house and also from an apartment house for a 24-hour run made up from the autographic record are shown on Fig. 9.

TABLE 2.

	Consumption.		Max. Rate per Min.	Duration of Max. Rate.
	Cu. Ft.	Gal. per Cap.	Cu. Ft.	Min.
Thursday, June 5......	65	81	1.00	3.0
Friday, June 6........	24	36	1.65	2.0
Saturday, June 7......	46	58	1.33	1.5
Sunday, June 8........	34	42	Pen out of order	...
Monday, June 9.......	52	64	2.20	2.0
Tuesday, June 10......	43	53	1.30	2.5
Wednesday, June 11...	68	85	1.00	2.0
Thursday, June 12.....	68	85	1.25	4.0

From this study it appears that probably in the first house (Fig. 1) at least 11 per cent. of the water delivered was unrecorded by the meter, while for the entire twenty-four hours, except for three minutes at about 10.43 A.M., the rate of draft was below 2 gal. per minute. The upper figure (Fig. 1) on the diagram shows these rates graphically for the single dwelling, while the lower figure (Fig 2) shows the rates for the apartment house mentioned below. The most interesting matter in relation to both of these diagrams is perhaps a condition which is clearly brought out, namely, that for most of the time the flow through the meter lies in the zone between the 90 per cent. and 98 per cent. accuracy ordinarily guaranteed from disk meters. If this condition is characteristic of meter performance it at least offers an explanation for accounting for some of the hitherto unaccounted-for water reported from fully metered water departments, ordinary rates appearing to occur on that portion of the scale where the registration is the least accurate in the meters used.

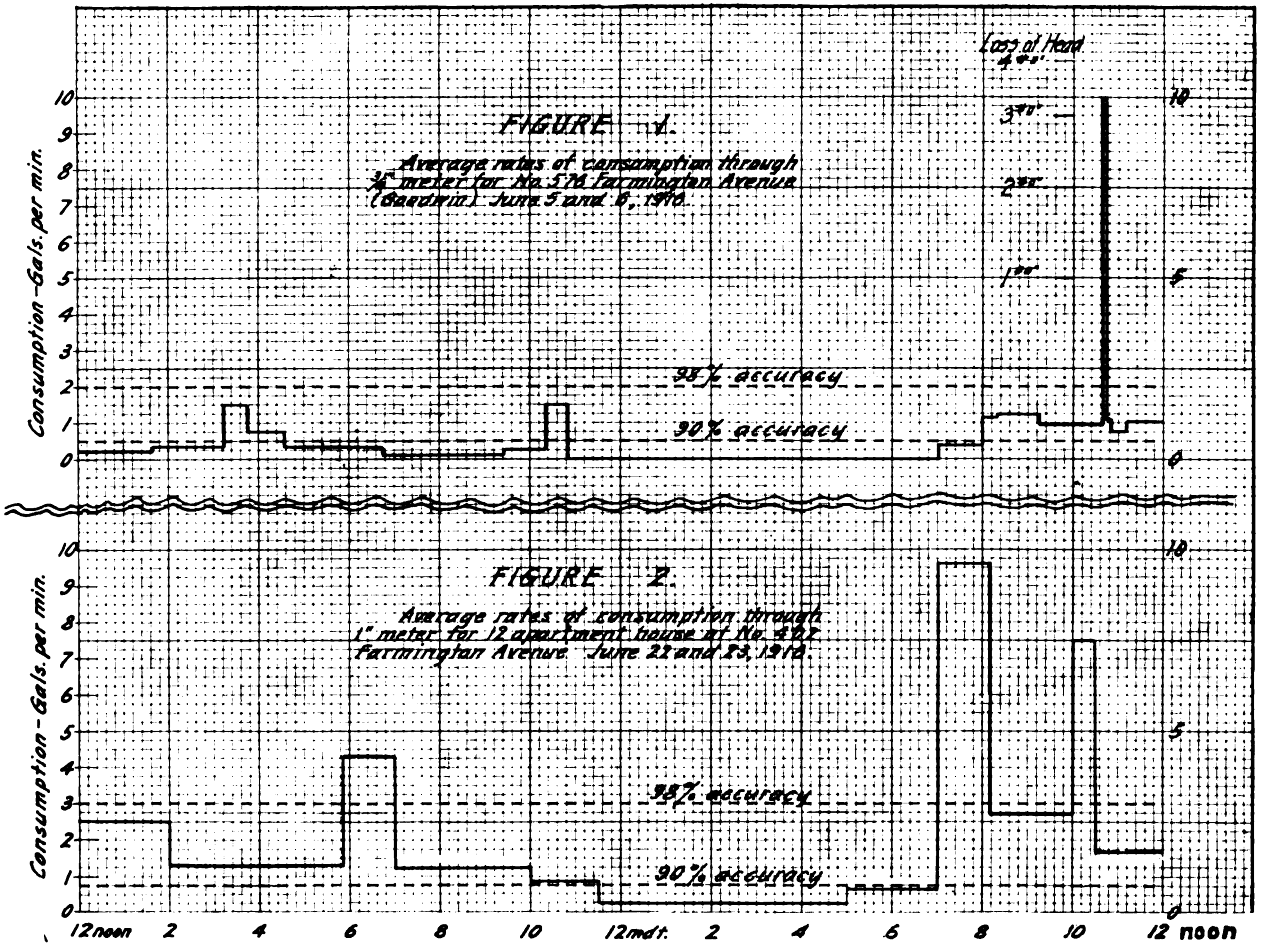


Fig. 9. Diagram giving Rates of Flow as Indicated by Charts.

TABLE 3.

RECORD FROM METER ON NO. 576 FARMINGTON AVENUE. ¾-IN. METER.
JUNE 5 AND 6, 1916.

1	2	3	4	5	6	7	8
Time.	Elapsed Time.	Observed Quantity.		Rate	Duration of Flow.	Probable Accuracy of Measurement Based on Meter Mfrs' Schedule.	Probable Actual Delivery of Water.
	Min.	Cu. Ft.	Gal.	Gal. per Min.	Per Cent. of 24 Hr.		Gallons.
10.50–11.10	20	2	15.	0.75	1.4	0.91	16.5
12 N.	50	7	52.5	1.05	3.5	.93	56.5
1.40	100	3	22.5	.23	6.9	.80	28.1
3.15	95	4	30.	.32	6.6	.85	35.3
3.45	30	6	45.	1.50	2.1	.96	46.8
4.35	50	5	37.5	.75	3.5	.91	41.3
6.45	130	5	37.5	.29	9.0	.80	47.0
9.25	160	2	15.0	.10	11.1	.60	25.0
10.20	55	2	15.0	.27	3.8	.80	18.7
10.50	30	6	45.0	1.50	2.1	.95	47.3
7 A.M.	490	0	0.	.00	34.0	...	....
8.00	60	3	22.5	.38	4.2	.85	26.5
8.20	20	3	22.5	1.13	1.4	.94	23.9
9.15	55	9	67.5	1.22	3.8	.94	71.8
10.40	85	6	45.0	.53	5.9	.90	50.0
10.43	3	4	30.0	10.00	.2	1.00	30.0
10.50	7	1	7.5	1.07	.5	.93	8.1
	1 440	68	510.0	.36	100.0	0.89	572.8

Six persons, 86 gal. per capita.

Probable amount	572.8 gal. in 24 hr.
Recorded amount	510.0 gal. in 24 hr.
Unrecorded	62.8 gal. in 24 hr.

11 per cent. not recorded.

Column 7 of the table was obtained by straight-line proportion between the low rate giving 98 per cent. and the rate giving 90 per cent. for the given sized meter based on the schedule of the Meter Manufacturers' Exchange. From present information available it appears that the percentage of registration between the given limits varies as a curve instead of as a straight line, and the actual at present registration is less than that used in this paper.

The house under consideration is a one-family dwelling in the best residential part of Hartford, built perhaps twelve or fifteen years ago. It is generally occupied by six persons and in the year 1916 had a total use of 16 400 cu. ft., equivalent to an average per capita consumption of 56 gal. per day. The water pressure here is about 70 lb. The premises were originally served through a ⅝-in. meter. A complaint was made of inadequate service, and a new 1-in. service pipe was installed by the owner. A request for a 1-in. meter was made on advice of the plumber. A ¾-in. meter was attached, and the owner was rather put out at first because the larger-sized meter was not installed. The water fixtures in this house comprised:

Three set tubs in laundry, with hot and cold water.
One sink in laundry, with hot and cold water.
One sink in kitchen, with hot and cold water.
Two water-closets, tank type.
Four washstands, with hot and cold water.
One bathtub, with hot and cold water.
Two ¾-in. hose bibs in garage.
One ¾-in. sill cock.

In investigating this house the following report was made: "With two cold-water faucets open in the basement laundry and one hose connection in the garage, only a fair flow of water was obtained in the bathroom faucets on the second floor. With this demand the ⅝-in. meter showed a rate of 2.25 cu. ft. per minute, which is in excess of the 'maximum proper rate of flow.' A ¾-in. meter is recommended." This installation has been perfectly satisfactory.

In one of the highest class apartment houses recently built, (Cut 9, Fig. 2), containing 12 separate suites and having an average population of 40, the use of water in 1916 was at a rate of 72 gal. per capita. The static pressure in the street main is about 70 lb. per sq. in. There is a 1-in. meter on the premises, which is giving satisfaction.

This house was fitted with the most modern plumbing throughout, and has a garage attached.

The following table shows average rates from noon on Wednesday, June 22, 1916, together with computations indicating conditions which exist relative to recorded use of water.

TABLE 4.

1	2	3	4	5	6	7	8
Time.	Elapsed Time.	Observed Quantity.		Equiv. Rate.	Duration of Flow.	Probable Accuracy of Measurement Based on Meter Mfrs.' Schedule.	Probable Actual Delivery of Water.
	Min.	Cu. Ft.	Gal.	Gal. per Min.	Per Cent. of 24 Hr.		Cu. Ft.
12 N.-2 P.M.	120	40*	299	2.5	8.3	97%*	41.4
2.00-5.50	230	40	299	1.3	16.0	92	43.5
5.50-7.00	70	40*	299	4.3	4.9	100*	40.0
7.00-10.00	180	30	224	1.24	12.5	92	32.6
10.00-11.30	90	10	75	0.83	6.3	90	11.1
11.30-5 A.M.	330	10	75	0.23	22.9	80†	12.5
5.00-7.00	120	10	75	0.62	8.3	90	11.1
7.00-8.10	70	90*	673	9.6	4.9	100*	90.0
8.10-10.00	110	40*	299	2.7	7.5	99*	40.5
10.00-10.30	30	30*	224	7.5	2.1	100*	30.0
10.30-Noon	90	20	150	1.67	6.3	93	21.5
	1 440	360	2 692	1.87	100.0	96.3	374.2

* Assumed as accurate. † Estimated accuracy.

According to this record there was comparatively accurate registration of the amount of water supplied for less than seven hours. During the remainder of the twenty-four hours the registered amount of water seems to have been at least from 8 per cent. to 10 per cent. less than that actually delivered, and during five and one-half hours probably only a very small proportion was recorded. Applying the probable per cent. registration given in Column 6 to the amount delivered in Column 3, Column 7 results in a total discrepancy of about 14 cu. ft., or 3.7 per cent. unaccounted for in this service. At 12c. per 100 cu. ft., this condition means a loss of $6.13 per year to the department.

Six dollars per year is about the amount paid on many services supplying small families on which $\frac{5}{8}$-in. meters are installed at a present cost of $10. There seems to be no logical reason why it is not as desirable to receive pay for all water passing through the service, whether it be a large or small consumer. If a more sensitive measuring device than those at present in use will necessitate paying a higher price than the present type of meter costs, water departments can well afford to pay the additional cost if they can be assured of more accurate results than seem possible with the present meter.

The Brown School chart (not shown) shows conditions as to use of water in a large public-school building relative to the normal rates of use of water there.

Maximum observed rate of use of at least 10 cu. ft. of water continuously as produced by normal use.....	5.9 cu. ft. per min.
Maximum observed rate of short duration and of small quantity (at recess time)........................	6.0 cu. ft. per min.

The fixtures supplied by this meter are as follows:

Water-closets (high tank, flushed by seat)........................	23
Urinals (automatically flushed from three tanks of same size as for closets)..	12
Washstands	13
Drinking fountains..	6
Faucets (equivalent to slop sink)................................	2
Boiler for heating (low pressure, return feed)......................	1

Five hundred pupils and 15 teachers use these fixtures.

There are ten rooms, 31 ft. by 27 ft., in this building.

The 2-in. meter originally in this building was capable of properly passing 20 cu. ft. of water per minute. The maximum observed rate under natural conditions of use was but 6 cu. ft. per min.

This meter was replaced with a 1-in. meter at a saving of $42 on present prices. In addition to this, the accuracy of registration was increased by use of the smaller meter and the amount of unpaid-for water reduced.

A chart from a laundry shows conditions where large quantities of water are used continuously during the day and thus indicating the type of meter which should be used under similar conditions.

Here is a 2-in. service, about 50 ft. long, from the main to the meter. Inside, about 75 ft. of 2-in. pipe carried the water from the meter to the principal source of use.

The following information was obtained relative to the usual rates of use of water:

Maximum observed rate of use of at least 10 cu. ft. of water continuously as produced by normal use	20 cu. ft. per min.
Maximum observed rate of short duration, 5 cu. ft. in 15 seconds	20 cu. ft. per min.
Rate produced when filling one large washing machine	17 cu. ft. per min.
Rate produced by opening two or more inlets to large washing machines	20 cu. ft. per min.

The limit of the system is apparently 20 cu. ft. per min.

The fixtures supplied with water at this laundry are as follows:

Washing machines — very large	1
large	5
small	3
Water-closets, high tank	3
low tank	1
Sinks	2
Set tubs	7
Faucets in barn (6 horses stabled in barn)	2
Boiler, 100 h.p. low pressure, return feed	1

There are 60 employees at this establishment.

The following information was obtained relative to the amount of water used in laundry washings:

Number of fillings of washing machine for flat work	5
Number of fillings of washing machine for starch work, such as collars, cuffs, dress shirts, etc.	8
Cubic feet of water used for 50 washing machine loads requiring 265 fillings	3 890
Cubic feet of water per filling of washing machine	14.7
Cubic feet of water per load in washing machine	78

The 2-in. Trident Crest meter on this laundry is capable of properly passing 33 cu. ft. of water per minute. The maximum possible amount which the piping system is capable of delivering is apparently 20 cu. ft. per min. The meter is able to handle this quantity easily. A service for any similar installation with more adequate piping should be at least 3-in.

The records of the use of water in both the private house and the apartments are representative of conditions in a large number of houses in Hartford and elsewhere. Probably the demand in these houses is much larger than in many others, yet even in these examples it appears that the maximum rates observed are only just within the limits of the 4 per cent. accuracy which is the best the meter manufacturers are willing to guarantee. The bulk of the use of water in private houses of the class here noted is apparently at a rate of from 0.5 to 1.0 gal. per minute. The accuracy of registration for this rate on the basis of the meter manufacturer's schedule for the size of meter installed is probably about 92 per cent., that is, on such services in ordinary use about 8 per cent. of the water used is not accounted for. A ⅝-in. meter would account for a much greater proportion of the water drawn. On the other hand, its use would be totally unsatisfactory to the consumer because it would cut down the pressure when large quantities of water were required and so interfere with the efficient operation of the plumbing.

All that has been said regarding the accuracy of registration of water for the private house applies with equal force to the apartment house. In this case with the 1-in. meter a rate of flow of ¾ gal. per min. only is guaranteed for registration within 90 per cent. accuracy, and flows of from 1 to 1.5 gal. per min. would probably be recorded within from 92 to 95 per cent. of the true amount. An inspection of the chart for this service indicates that for at least during eighteen out of the twenty-four hours the demand for water was less than 1.5 gal. per min., and at rates which from 90 to 95 per cent. only, was recorded for payment to the department.

In his report in water waste, Mr. Frank A. Barbour (Journal N. E. W. W. A., Vol. XXX, 1916, p. 440) states: "Even in fully metered systems about 20 per cent. of the total water supply is unaccounted for by sale to consumers." And in their report on Water Rates (Journal N. E. W. W. A., Vol. XXX, 1916, p. 459) the committee stated "its belief that under-registration of meters formed a substantial part of the total loss in systems where the pipes and service pipes have been carefully and systematically followed up for leakage. . . ."

The conditions shown above and the expressed opinions of specialists in water consumption matters indicates plainly that the time has come when more attention should be given to the design of meters, with a view to greater accuracy on low flows and

TABLE 5.

MAXIMUM PROPER RATE OF FLOW AND LOST HEAD THROUGH DISK METERS, TOGETHER WITH THE LENGTH OF STRAIGHT PIPE WHICH GIVES THE SAME LOST HEAD AT THIS RATE.

(Based on Williams and Hazen Tables.)

Size of Meter.	Ordinary Maximum Rate of Flow (approx.)		Head Lost at This Rate.		Approximate Length in Feet of Straight Pipe to Give Same Loss of Head as Meter.							
In.	Cu. Ft. per Min.	Gal. per Min.	Lb.	Ft.	¾ in.	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
⅝	2.2	16	20	46	50	165						
¾	3.4	25	20	46	20	70	600					
1	6.7	50	20	46		20	160	450				
1½	11.2	85	20	46			60	170	1 250			
2	17	130	20	46			30	80	570	2 300		
3	45	335	20	46				15	100	400	2 900	
4	70	525	20	46					45	175	1 200	
6	120	900	20	46						65	460	1 900

TABLE 6.

Information Submitted with Proposals for Furnishing Water Meters to the Board of Water Commissioners, City of Hartford.

Bids opened January 24, 1916.

Number of Meters to be furnished: 300–⅝", 225–¾", 75–1", 15–1½" and 10–2".

Bidder.		Hersey Mfg. Co.	Pittsburgh Meter Co.	Hersey Mfg. Co.	H. R. Worthington.		Union Water Meter Co.	Pittsburgh Meter Co.	Neptune Meter Co.	Thomson Meter Co.	National Meter Co.
Name of Meter.		Model F.	Keystone Type W.	Model FF.	Model G.	Model D.	King.	Keystone Type DC.	Trident.	Lambert.	Nash.
(*a.*) Price,	⅝" complete,	$5.60	$5.60	$6.00	$5.50	$6.00	$6.97	$6.80	$8.00	$8.00	$9.00
	⅝" by parts,	7.52	8.02	7.52	6.41	9.16	9.40	9.01	11.55	9.36	9.63
	¾" complete,	8.00	8.40	8.60	9.50	10.00	9.40	10.20	12.00	12.00	13.50
	¾" by parts,	10.40	10.46	10.40	10.14	12.42	13.67	12.75	15.25	12.30	13.395
	1" complete,	11.20	11.20	12.00	12.50	13.00	12.90	13.60	16.00	16.00	18.00
	1" by parts,	13.58	15.25	13.58	13.77	16.72	18.20	18.33	22.50	16.73	19.48
	1½" complete,	‡24.00		‡24.00	‡26.00	26.00	24.98	25.50	30.00	30.00	35.00
	1½" by parts,	‡26.18		‡26.18	‡*29.94	*29.94	42.30	40.85	41.10	27.96	31.90
	2" complete,	‡40.00		‡40.00	‡45.00	45.00	37.97	42.50	50.00	50.00	55.00
	2" by parts,	‡42.01		‡42.01	‡46.78	46.78	57.30	59.64	53.60	46.34	55.38
(*b.*) Number of oscillations of disk to register l. c. f. of water.	⅝" Meter,	430.	357.	300.	296.	296.	273.	289.	362.25	295.	268.
	¾" Meter,	220.	194.	163.	161.	161.	139.	159.	246.5	155.	199.
	1" Meter,	114.	100.	80.	97.8	97.8	73.	79.8	92.55	75.	81.
	1½" Meter,	‡37.		‡37.	‡37.5	37.5	35.	37.9	35.4	36.	59.
	2" Meter,	‡24.		‡24.	‡22.5	22.5	19.	19.5	19.2	19.	28.
(*c.*) Weight in pounds.	⅝" Meter,	8.	7.5	9.	7.5	9.	9.75	10.5	12.5	10.25	13.5
	¾" Meter,	12.	13.5	13.	10.5	14.	13.2	14.25	15.0	12.50	18.0
	1" Meter,	16.	18.33	18.	15.5	17.	19.3	21.5	26.0	18.25	28.0
	1½" Meter,	‡34.		‡34.	‡33.0	33.	39.2	41.0	39.0	31.75	55.0
	2" Meter,	‡53.		‡53.	‡60.0	60.	50.0	62.0	50.0	53.00	80.0
(*d.*) Maximum proper rate of flow cu. ft. per min.	⅝" Meter,	3.	3.	3.	2.5	2.5	3.3	3.33	3.0	2.0	2.
	¾" Meter,	5.	4.	5.	4.0	4.0	4.8	4.66	5.4	4.0	4.
	1" Meter,	9.	8.	9.	7.0	7.0	8.5	8.66	9.0	8.0	8.
	1½" Meter,	‡14.		‡14.	‡12.0	12.0	13.25	14.0	13.0	12.0	12.
	2" Meter,	‡25.		‡25.	‡20.0	20.0	20.25	22.0	22.0	25.0	20.0

(e.) Guaranteed accuracy. 1. At maximum proper rate of flow.	⅝" Meter,	98.0%	98.0%	98.0%	99.0%	99.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	¾" Meter,	98.0%	98.0%	98.0%	99.0%	99.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	1" Meter,	98.0%	98.0%	98.0%	99.0%	99.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	1½" Meter,	‡98.0%		‡98.0%	‡99.0%	99.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	2" Meter,	‡98.0%		‡98.0%	‡99.0%	99.0%	98.0%	98.0%	98.0%	98.0%	98.0%
2. At following intermediate rates, cu. ft. per min.	⅝" Meter, 0.06,	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	¾" Meter, 0.11,	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	1" Meter, 0.17,	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	1½" Meter, 0.30,	‡98.0%		‡98.0%	‡98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
	2" Meter, 0.60,	‡98.0%		‡98.0%	‡98.0%	98.0%	98.0%	98.0%	98.0%	98.0%	98.0%
3. At minimum rate of flow, cu. ft. per min.	⅝" Meter, 0.022,	90.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%
	¾" Meter, 0.044,	90.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%
	1" Meter, 0.066,	90.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%
	1½" Meter, 0.13,	‡90.0%		‡90.0%	‡95.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%
	2" Meter, 0.27,	‡90.0%		‡90.0%	‡95.0%	95.0%	90.0%	95.0%	95.0%	90.0%	95.0%
(f.) Drop in pressure with maximum rate of flow with strainer in place in meter in lb. per sq. in.	⅝" Meter,	29.	30.	29.	6.	17.	24.	25.	12.5	†7.5	14.
	¾" Meter,	29.	30.	29.	18.	24.	24.	27.	16.0	22.5	18.
	1" Meter,	29.	30.	29.	20.	25.	24.	32.	25.0	30.0	24.
	1½" Meter,	‡25.		‡25.	‡20.	20.	25.5	26.	16.0	12.5	19.
	2" Meter,	‡25.		‡25.	‡22.	22.	26.	28.	11.0	27.5	20.

‡ Model D. † Probably without strainer. With strainer, 14 to 16 lb. per sq. in. by test.
* This figure given in bid. Total apparently should be $27.98.

STATED REQUIREMENTS IN SPECIFICATIONS.

	⅝ in.	¾ in.	1 in.	1½ in.	2 in.
Maximum proper rate of flow at least (cu. ft. per min.).	2.	4.	8	13.3	20.
Accuracy of registration at (1) maximum proper rate, (2) at stated inter. rate,	For all sizes,			98–100%	
At (3) minimum rate stated above,	For all sizes,			90–100%	
Drop in pressure at above stated maximum proper rate,	For all sizes,		not more than 30 lb. per sq. in.		

TABLE 7.

AVERAGE CONDITIONS APPLICABLE TO DISK METERS.

Size. Inches.	Maximum Proper Rate for Use. (Approx.)		Average Pressure Loss.		Limits of Accuracy Proposed by Meter Mfrs.' Exchange.		Ratio Carrying Capacity with Given Loss of Pressure.	Present Prices.	Approximate Delivery with Stated Loss of Pressure. Gal. per Min. above. Cu. Ft. per Min. below.		
	Permissible.	Ordinary.	Permissible.	Ordinary.	98 to 102 Per Cent.	90 Per Cent.			Loss Lb. per Sq. In.		
	Gal. per Min. above. Cu. Ft. per Min. below.		Lb. Sq. In.		Gal. per Min.				5 Lb.	10 Lb.	15 Lb.
$\frac{5}{8}$	22.5 (3)	16 (2.2)	36	20	20 to 1	0.25	1.0	$10	8.4 (1.1)	11.8 (1.6)	14.5 (1.9)
$\frac{3}{4}$	33.8 (4.5)	25 (3.4)	36	20	35 to 2	0.50	1.5	$15	12.6 (1.68)	17.8 (2.37)	21.8 (2.91)
1	67.5 (9)	50 (6.7)	36	20	60 to 3	0.75	3.0	$30	25.2 (3.36)	35.5 (4.74)	43.6 (5.82)
1½	112.5 (15)	85 (11.2)	36	20	100 to 5	1.50	5.0	$40	42 (5.6)	59 (7.90)	73 (9.7)
2	168.5 (22.5)	130 (17)	36	20	160 to 8	2.00	7.5	$62	63 (8.4)	89 (11.85)	109 (14.5)

less friction on the high ones, even if the cost of the meter is increased thereby. Also it appears that too much "tolerance" in meter design cannot be tolerated by water departments, especially by those where water is filtered or pumped and every unnecessary gallon sent to the distribution system means not only waste of water but increase in the annual cost for maintenance and operation. The compound meter was a long stride toward more accurate accountability on those services where there are intermittent calls for large quantities of water. What now seems to be needed is re-design of present meter mechanism or a new water-measuring device for use on services, now covered by disk meters 2-in. and less in size, which will give more accurate measurement of small flows with less loss of head at the larger rates.

In the prospectus issued by most meter manufacturers is a table stating the maximum proper rate of flow to which the particular sized meter is adapted. Tests of various meters of the given sizes show that the loss of pressure at this rate is usually considerably more than can be spared in ordinary practice, and, in addition, the rate at which the disk must oscillate with this flow is a menace to its safety. On this account the following rates are suggested as a safe maximum, which under ordinary conditions it is inadvisable to exceed; 20 lb. per sq. in. loss has been taken as the maximum allowable loss in this table. Based on the quantity of water which can be obtained through the meter with this loss of head a table (Table 5) has been prepared giving the length of straight pipe of several sizes having an equivalent loss of head.

Table 6 gives information submitted with proposal for furnishing water meters to the Board of Water Commissioners, Hartford, in 1916. A study of the items in this table shows the wide variation in details of the meters offered by different makers. In addition to this, actual tests, with sample meters submitted with the bids, showed that some of the data given varied considerably from the facts.

For the purpose of having data at hand concerning losses in other portions of the service besides the meter, tests were made of losses of head in various fittings used in connecting up service

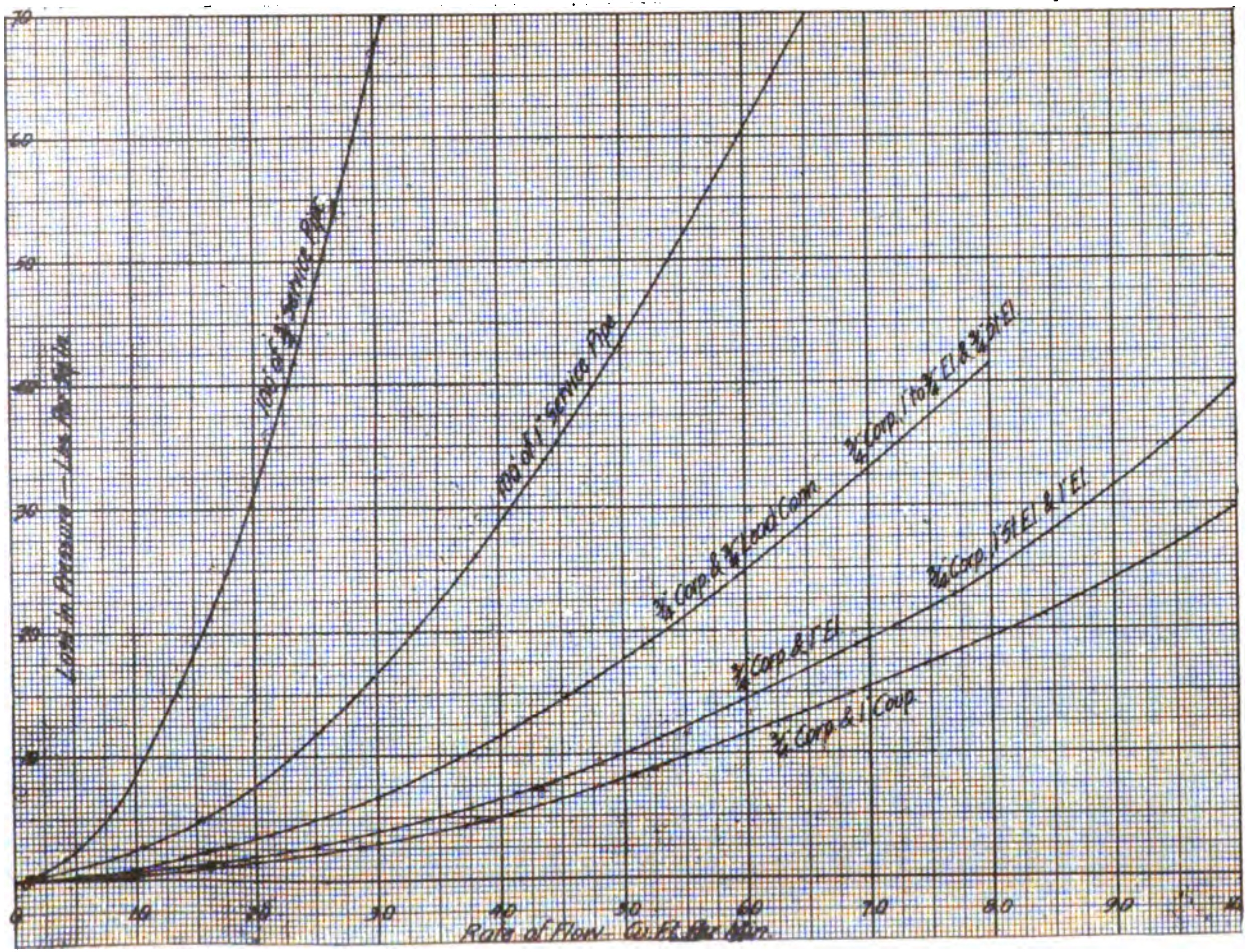


Fig. 10. Loss of Head in ¾-in. Service Pipe and Fittings.

pipes. These tests were carefully conducted, but no attempt was made to get results under theoretical conditions; the intent was to obtain information applicable to ordinary trench work of good character. For the purpose, a length of 6-in. cast-iron pipe was tapped by the regular service-pipe gang and a service installed by them in the ordinary way. The ends of the 6-in. pipe were capped and the pipe filled and kept under pressure by means of two lines of 2½-in. fire hose.

Cut 10 gives losses of pressure through ¾- and 1-in. service pipe and ¾-in. corporations with various connections.

Cut 11 gives losses of pressure through 1- and 1½-in. service pipe and 1-in. corporations with various connections.

Table 7 puts in tabular form some information applicable to average conditions and is intended only for use under ordinary or average conditions.

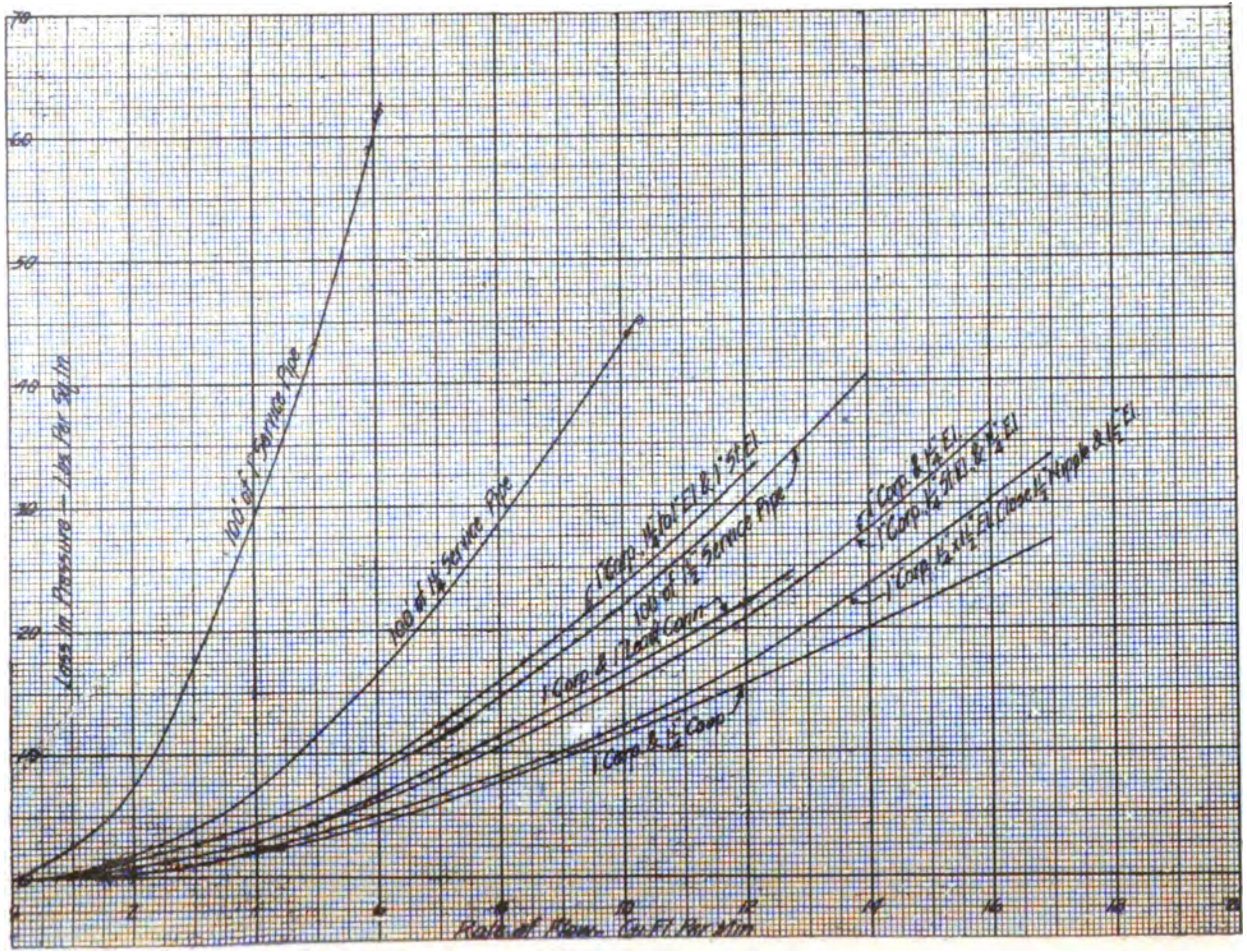


FIG. 11. LOSS OF HEAD IN 1-IN. AND ¾-IN. SERVICE PIPE AND FITTINGS.

Discussion.

Vice-President Killam. Speaking of the per cent. of water unaccounted for by meters, Mr. Dunn some years ago took a system which was absolutely porous, cement-lined pipe, and has brought the system up so that it is now in excellent condition, and the per cent. of water accounted for is remarkable. We should like to hear from him.

Mr. Lewis R. Dunn. Mr. President, I am willing to answer any questions which any gentleman may wish to ask me. I may simply say that when I took the system I was with the Goodhue & Birney Company. In about 1900 the town of Revere bought the Revere end of the system, and that left the town of Winthrop on the company's hands. I had been with them since 1890, and they sent me over to Winthrop to run that end of it. Mr. Goodhue wasn't much in favor of meters, and when I took charge of the plant, with a population of something like eight or nine thousand people, there was a consumption of about 140 gal. per capita. Now we have, with all the soldiers at the fort, somewhere about fifteen or sixteen thousand people, and I think the consumption last month was 52 gal. The reduction has all been brought about by meters. The main-pipe work has been thoroughly done, and we have, perhaps, paid as much for repairs as any town or city in the Metropolitan District; but the fact remains that there haven't been but three main-pipe leaks in three years. We have had a little trouble with having to re-pack the tops of our valves, but that has been very small; and I give the whole credit for the water that has been saved, to the town of Winthrop, to the thorough installation of meters.

Vice-President Killam. Can you give us the percentage accounted for last year and the year before?

Mr. Dunn. I think it has been accounted for within less than three per cent. for three years running.

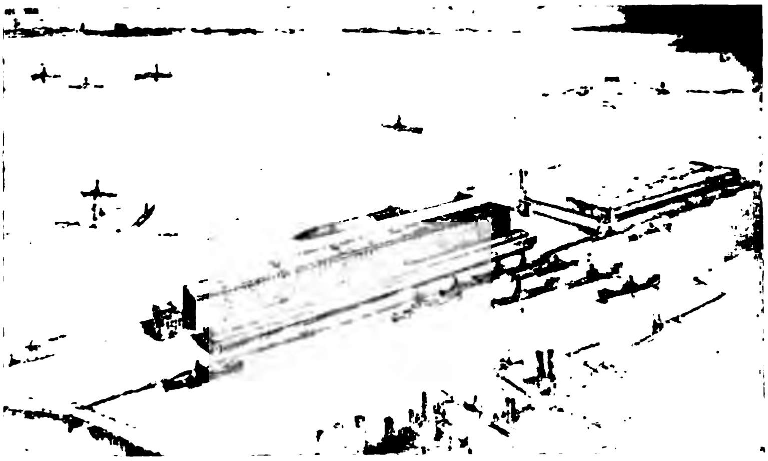
QUARTERMASTER TERMINAL REQUIRED FOR WAR WORK.

BY MAJOR CHARLES R. GOW, CONSTRUCTING QUARTERMASTER AT BOSTON.

[*September 11, 1918.*]

Mr. President and Fellow-Members, — From the day when this Government entered into hostilities with Germany it became apparent to all of us that we were confronted with a very difficult and serious problem in the organization and equipment of the millions of troops required, and their transportation across three thousand miles of sea to the fighting front on the other side. I think that probably a great many of you have failed to realize the magnitude of the problem which still confronts the Government once the troops are safely transported across the sea, in maintaining and supplying them. It is estimated by competent military authorities, based on the experience of the belligerents so far, that there are required on the average 50 lb. of supplies per man per day. On this basis, with approximately two million troops, that we have or will shortly have on the other side, there is required a daily shipment of approximately 50 000 tons of supplies from these shores, and the ultimate requirement, with the anticipated army of five millions, will be a shipment daily of 125 000 tons.

Now, to make these figures impressive it is necessary to analyze them. For instance, a 40-car train, which I believe is about the maximum that we haul here in New England, will carry on the average about 1 000 tons. This means that the ultimate requirements for overseas shipments, merely for the supply of our troops, will require the daily receipt at some shipping terminal or terminals of 125 such trains; or, expressed in a different way, one train of 40 cars capacity rolling into some terminal somewhere on the Atlantic seaboard every twelve minutes out of the twenty-four hours, to be unloaded, rehandled aboard ship, and shipped overseas. Expressed in terms of shipping, the average transatlantic merchant ship will carry, I believe, somewhere in the vicinity of 6 000 tons. This would mean the daily sending of about 21 such ships out of some port or ports on this side; and, assuming that they required on the average, say, a month for a round trip for loading, making the voyage, docking and unloading, it would necessitate, roughly speaking, the services of about 600 ships constantly plying back and forth from these shores to Europe with supplies merely for maintaining our army on the battle front.



General Perspective, Boston Army Supply Base.

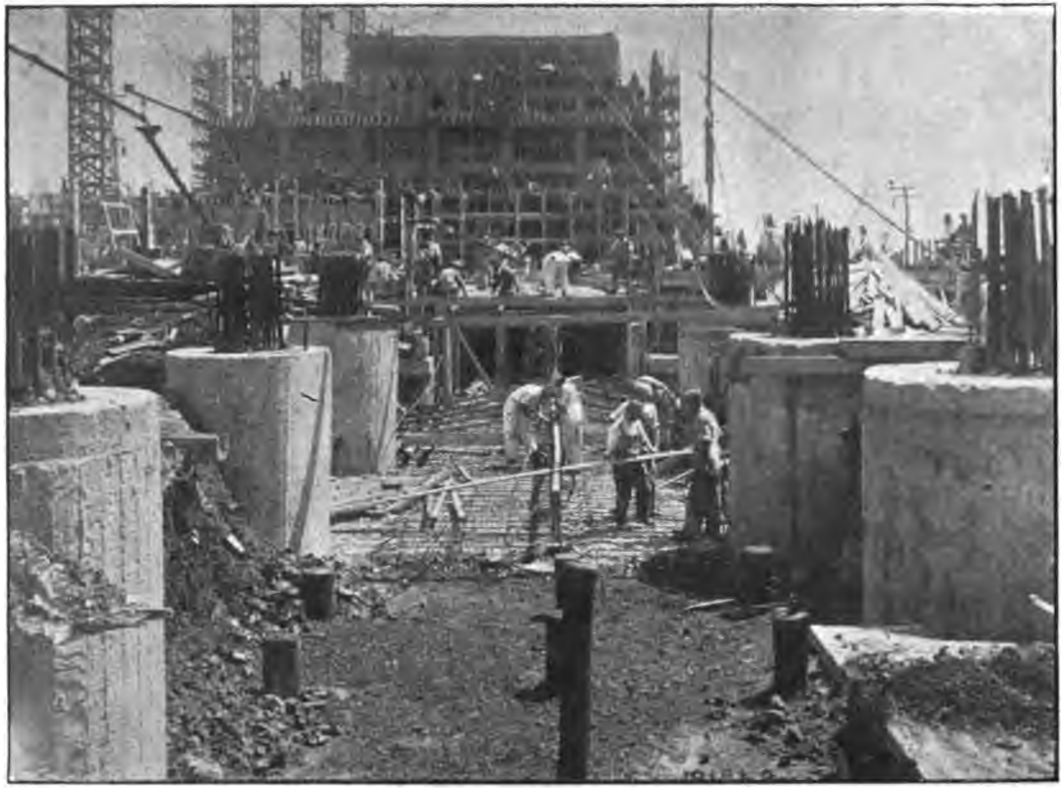
I think you will all appreciate the fact that shipping facilities, as they existed prior to the war, were not sufficient to maintain this service and, in addition, supply the nations allied with us with such necessary food and equipment and other supplies as are demanded. The Government, foreseeing this situation, late last year set to work to lay out a system of army supply bases, so-called, for the purpose of supplying our troops when they were in the field in France; and it is in connection with those supply depots that I am asked to speak to-day.

The present program calls for the construction of eight main supply depots, — one at Boston, another at Brooklyn, one at Port Newark, another at Philadelphia, and others at Baltimore, Norfolk, Charleston, and New Orleans. The Boston terminal will be the second in size, second only to the one at Brooklyn. I believe the estimated cost of the Brooklyn base is thirty-two millions, and of the Boston base twenty-eight millions. Some of these terminals are designed as permanent structures, to serve useful purposes after the war. Others are temporary in character, due to the locality and local needs or the difficulties of construction and the time available for building.

Of course if it were only necessary to receive by freight a definite amount of material and transfer it directly aboard ship that would present a rather simple problem. However, as you will readily see, in handling such vast quantities of material at a constant rate it would be impossible and impracticable to attempt to transfer this freight directly from the car to the ships, because the class of freight received in any given train might not correspond to what was required, and because the arrival of boats is more or less intermittent, and it would require the holding of trains for an undue period. Therefore it becomes necessary to establish a storage depot into which the freight may be transferred from the cars, stored, and reassembled in cargo lots for shipment by boat.

The next essential requirement to adequate storehouses is sufficient terminal facilities for the railroad. The railroad people estimate that there is required, generally speaking, trackage for about four times the number of cars which are expected to be received daily into the terminal; and, therefore, a substantial-sized freight yard is required in connection with any such army base. So we have as the requirements for a given case, first, accessibility by deep water, so that ocean-going vessels may dock; some adequate place for the assembling of cargo, in the nature of a wharf shed; suitable storage or warehouse capacity for holding a sufficient supply of goods so that any cargo may be readily assembled; and a freight yard of sufficient capacity to accommodate the daily arrivals of trains.

In the Boston case the situation seemed to be met by a location in South Boston, adjacent to the so-called Reserve Channel, and immediately southerly from the dry-dock site. At this locality the Government purchased, last winter, a tract of land approximately a mile in length, extending from the L Street bridge, where



Caisson Foundations of Storehouse.
(Also showing Pipe Tunnel.)

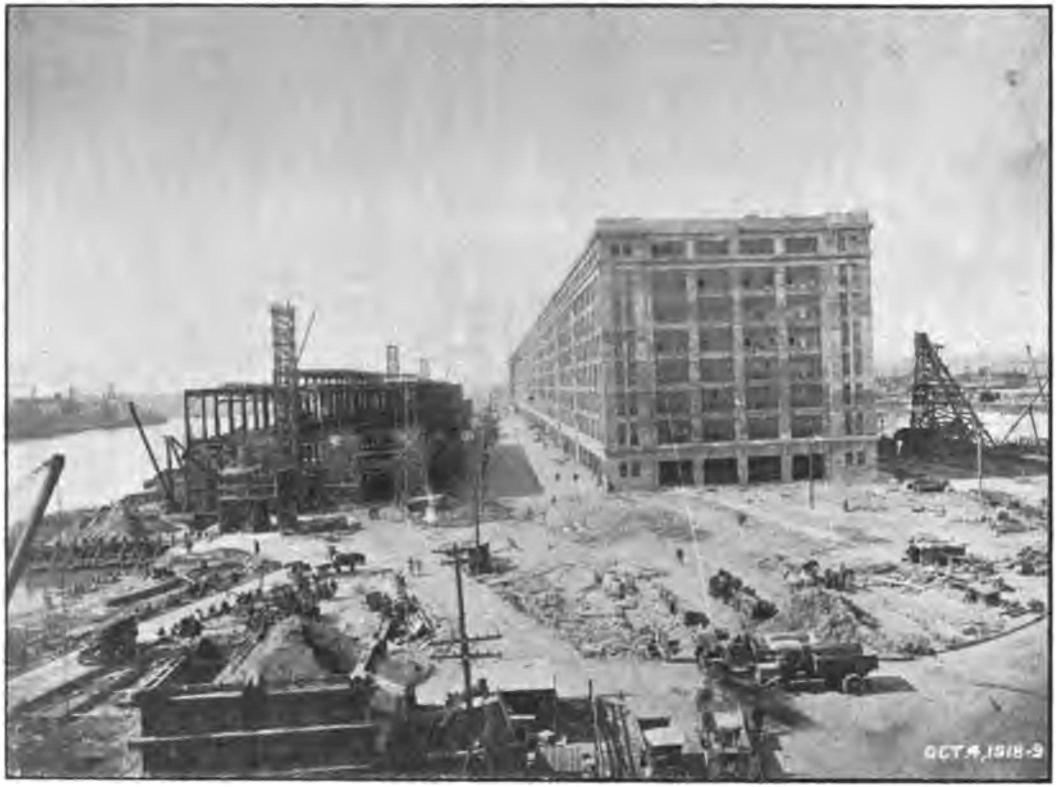
it crosses the Reserve Channel, due easterly to the main ship channel, and containing about fifty acres. On this site we are now erecting the necessary buildings and equipment for operating the base.

The most interesting feature, perhaps, is the storehouse building itself. This base is designed for a daily shipment of 6 000 tons of supplies, — in other words, a capacity of one vessel per day; and that constitutes about five per cent. of the total requirement. If it were not for the terminals existing prior to the war, there would be required twenty such installations built at Boston to take care of the aggregate demand.

To furnish a satisfactory storage medium we are constructing a storehouse building having an aggregate floor area of 1 600 000 sq. ft. This is contained in an eight-story structure, 126 ft. wide and 1 638 ft. long, divided into six independent buildings by means of a separation or fire wall. This building when completed will contain a total of 121 000 cu. yd. of concrete. It is built thoughout with reinforced concrete of the most permanent and substantial type, the floors designed for loads of 300 lb. per square foot and it is equipped with all conveniences, heating, lighting, and elevator service, and designed throughout not only for availability for storage purposes but also for manufacturing purposes after the war. In other words, it is built with the idea of turning it over after the war for purely commercial purposes.

On account of the soil conditions, it was necessary to carry the foundations 55 ft. below the surface of the ground to obtain a satisfactory bearing. The so-called caisson type of foundation was employed, carrying down the cylinder shaft into the ground, belling out on to hardpan at a depth of 55 ft. There were 577 of these caissons required, and the total cost of the caissons alone was a million and a half of dollars.

In spite of the difficulties of foundation construction and the volume of concrete, involving a total of 121 000 cu. yd., this building is approaching completion after a lapse of approximately five months from the time ground was broken. In other words, in five months' time, or by the first of October, the first of the coming month, — I think that is five months and a week, — this building, containing 1 600 000 sq. ft. and 121 000 yd. of concrete, will



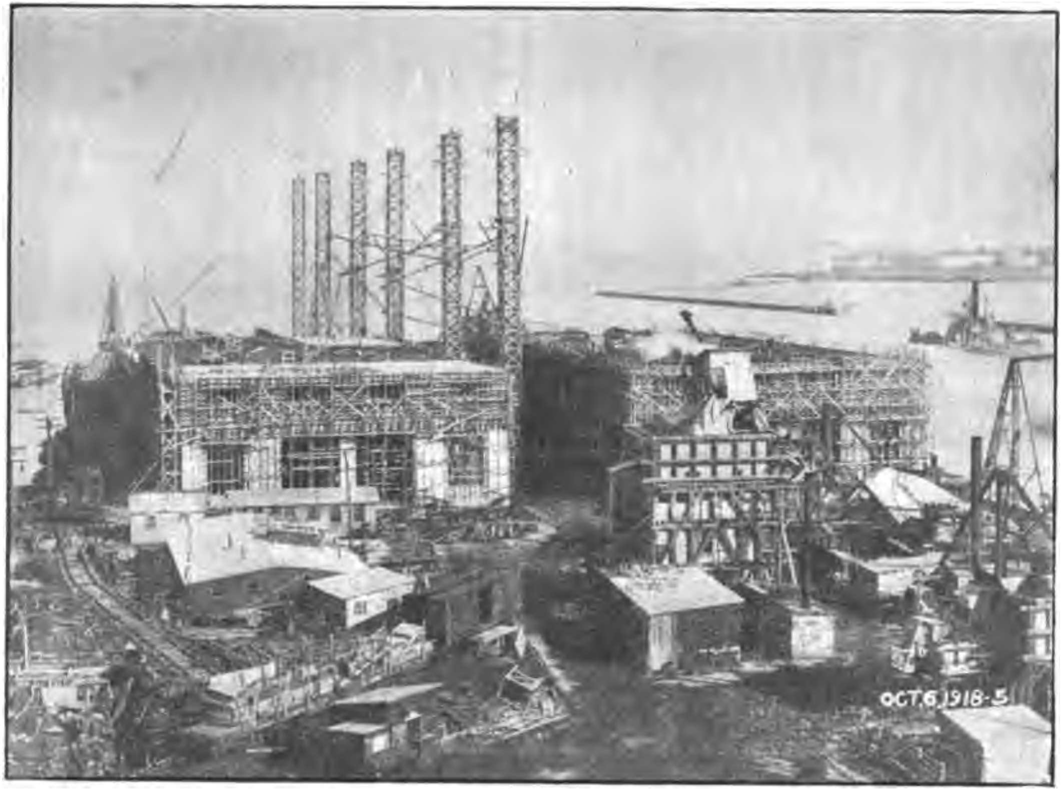
WHARF SHED AND STOREHOUSE.
(1 638 x 100 ft.)   (1 638 x 126 ft.)

have been completed, with the exception of some of the equipment. Of course the interior equipment is progressing with the construction of the building, and it will be entirely completed shortly thereafter, so that the building can be put into use as a storehouse at that time.

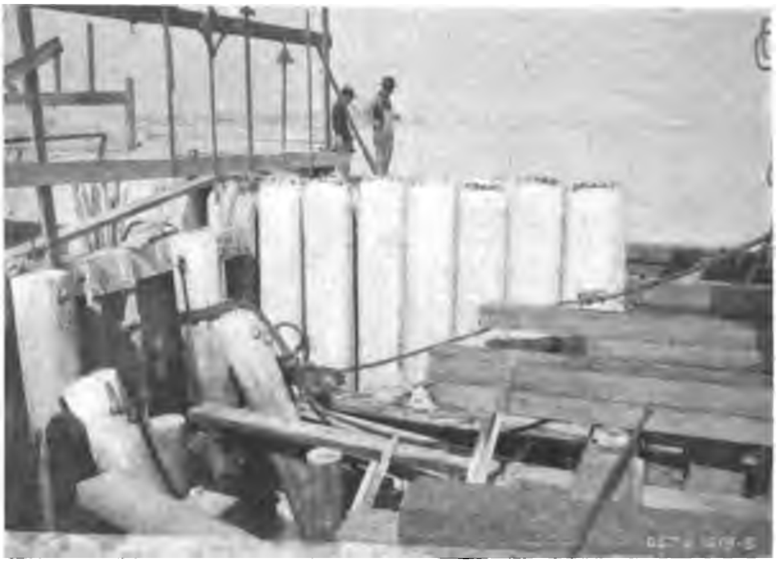
Parallel with the warehouse and separated by an 87-ft. paved roadway, there is another structure, which is known as the " wharf shed." This is the structure into which the cargo will be assembled for loading into ships. It is a two-story building, with a steel superstructure, concrete floors and walls, and is built entirely on wooden piles and a concrete deck. It required for this foundation some 30 000 wooden piles, and approximately 20 000 cu. yd. of concrete on top of the piles. The piling and concreting will be finished by the 25th of this month, and the structural steel, the superstructure, is already being erected. The balance of the work, it is expected, will require only a comparatively short period.

In addition to those two main buildings there is required what is known as a " navy pier shed." If it were not for the magnitude of the main storehouse, this building would itself constitute a very substantial volume of work. The pier shed consists essentially of two parallel buildings, each 924 ft. long and 100 ft. wide, built to a height of three stories. Here again the foundation difficulties made necessary very nearly as much work below ground as above; but this has now been completed and the superstructure work commenced. In connection with this we are driving, I think for the first time in Boston, a concrete sheet-pile bulkhead to retain the flow to either side of the pier. This sheet piling is 42 ft. long and 21 in. thick, and is being driven by means of water jets and extremely heavy driving apparatus.

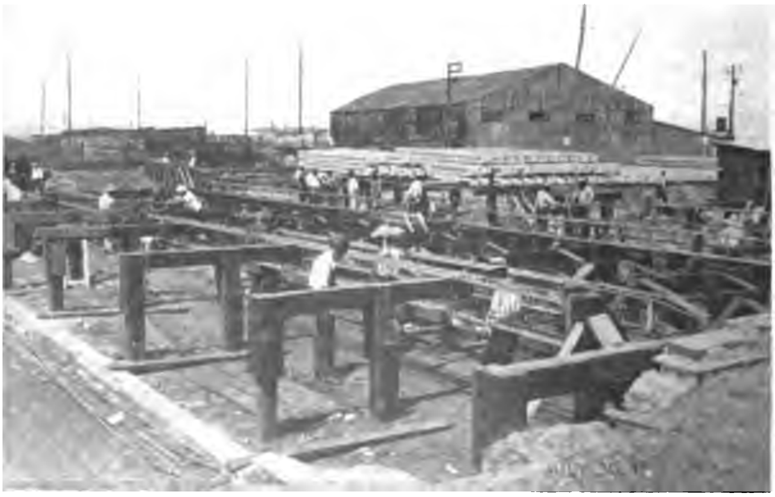
The railroad accommodations call for a total trackage of about 21 miles, of which 11 miles are outside the grounds and 10 miles inside. The freight yard proper is on land belonging to the Commonwealth adjacent to Summer Street and opposite the Commonwealth Fish Pier. There it has been necessary to use practically all the open land as railroad yard to get the necessary accommodation for storage of cars. I believe the capacity of the yard is approximately 750 cars for storage, and the remaining mileage is



NAVAL PIER SHED BUILDINGS.
(Each 924 x 100 ft.)



Concrete Sheet-Pile Bulkhead.



Forming and Curing Concrete Sheet-Piles.

inside the ground for distribution tracks and for open storage tracks.

The power house, or the house for heating the plant, will take 2 400 h.p. of boilers, and there will be in addition an electric substation and a machine shop.

The administration building, which has only just been designed and finally located, will be four stories in height and 50 by 120 ft., a substantial-sized building.

The number of men we have employed up to date has averaged about 5 500, with a maximum of 7 000. Of course this involves considerable difficulty at the present time, on account of the general scarcity of labor, but at no time has the work been seriously delayed due to lack of sufficient men.

The type of contract which was adopted for this work, and which is generally applied to work done by the Construction Division, such as the building of the several cantonments, the various ordnance plants, and the like, has been the so-called emergency war contract, under which the contractor is reimbursed for all expenses and is paid a fee based upon the cost of the work, but under a sliding scale. That is, the greater the cost of the work the less the rate or percentage which is paid as profit. That is the reason that in this particular case the maximum fee is reached early in the work. The maximum fee allowed under the contract is $250 000. Beyond $250 000 no additional fee can be paid, regardless of the amount of work.

This type of contract has been criticized more or less in some quarters because of misapprehension as to the nature of the fee. The maximum fee of $250 000 is obtained when the volume of work done amounts to $10 000 000. Beyond that, as I have stated, no additional profit is paid. Beginning with an allowance of 7 per cent. up to $100 000, the percentage gradually dwindles until at $10 000 000 the percentage is 2½, which amounts to $250 000, the maximum fee, and beyond that the contractor works for nothing, so far as his profit is concerned. So, in this particular case, the aggregate amount of work being estimated at something like $28 000 000, the contractor will receive considerably less than one per cent., and we anticipate that after he has taken out his overhead expenses, the Government war tax, and made a few other deductions, he will be fortunate if he has one half of one per cent. on the actual disbursements.

This type of contract, or some modification of it, is almost absolutely necessary, for work of this nature. In this particular case the preparation of the plans and the actual construction work began simultaneously. It would have been actually impossible, without a considerable waste of time, to have prepared plans and drawings in such detail as to permit any contractor to estimate carefully the requirements and the proper costs. Then, again, the changing conditions as to labor and the requirements as to overtime make it impossible to judge with any great degree of accuracy the ultimate cost of the work. For example, we find that a certain portion of the work is holding up some other necessary feature, and so orders are given to work on Sunday, when everybody is paid double time. Or it may be that a certain craft is forced to work, instead of the normal eight hours per day, ten, twelve, or even fourteen hours for a period, in order that its portion of the work shall catch up with the remainder. Under these conditions, of course, no contractor would be able to foresee just what his labor cost might be.

Then, of course, it is inevitable that in a work of this sort, of this magnitude, continual changes must be made. Conditions might arise which would make it desirable to change the form of construction or something, and the result would be that in the end the ordinary form of lump-sum contract would be entirely upset and some sort of an accounting would have to be made. Therefore this form of contract has seemed to work very satisfactorily to the Government and to the contractor. And it leaves the Government in the position where they can select their own contractor, based on his experience and reputation in the community and his general ability for that class of work, and put him at work immediately without the formalities which would be required to be gone through with before executing a lump-sum contract; and, in the main, the experience of the Construction Division has been that this is a decidedly favorable form of contract for this class of work.

The general labor situation, as I mentioned a few moments ago, has given some concern, and the tendency of everybody in these days to strike when they feel that there is an excessive demand for their services has given us more or less trouble. But in the main I think I ought to say that the attitude of labor, especially of labor leaders, with one or two minor exceptions, has been exceptionally pleasing for its spirit of loyalty and coöperation. Of course where so many men are involved, so many classes, many of them ignorant and entirely without education and without the ability to analyze questions of this sort, some of them are influenced by the occasional agitator, and as a result there have been the usual number of minor labor upsets and troubles which have usually been corrected when the proper parties have been appealed to and the men have been reasoned with.

There has been much criticism about work of this nature, due to the fact that the men individually receive such large sums of money for the work performed. This, however, is due to no fault of the men or of the Government. It is due to the necessities of the case. In order to harmonize and stabilize labor conditions, the Government has seen fit to establish certain standards applying to labor on all Government work which are deemed to be fair to labor and fair to the Government, and one condition was that where a job was done under union conditions the union conditions in the locality should apply, and where work was done under non-union conditions union officials in the neighborhood should not interfere. In this particular case of ours the work is done by a so-called close-shop contractor, employing exclusively union labor; and under the terms of the agreement — the so-called Baker-Gompers Agreement — it is necessary to comply with the prevailing local union conditions as to hours and pay. That means that after eight hours' work all skilled mechanics must be paid double time for all overtime; that the laborers must receive time and a half for overtime; that being the stipulation in the President's proclamation setting aside the eight-hour law as applying on Government work, that, in case more than eight hours was worked, time and a half should be paid for all overtime. Therefore, the rates of pay mount up very rapidly after eight hours, and you can readily appreciate the fact that in attempting to do the great amount of work in the time allotted, namely, eight months, it was absolutely essential to work longer than eight hours a day. As matter of fact we established at the beginning a ten-hour day, and that very frequently became a twelve- or a fourteen-hour day, — and very often it was seven days a week; with the result that union men on the work, mechanics of one sort and another, are receiving wages from $60 to $70 or $80 or $100, and even up to $110 a week for services rendered. We had one case of an electrician who operated an electrical sub-station, dividing the twenty-four hours with another electrician, and, due to the long hours and the seven-day week I think the night man's pay was $117 a week, which, of course, we felt to be excessive, but nevertheless it is in exact accordance with the requirements of the local union regulations as to pay, and, such being the case, it is unjust to attribute it to the greed of the laborer or to the inefficiency of the contractor. It is one of the unfortunate penalties we have to pay for being in a hurry, having so short a time with so much work to do.

The total project will require, all together, 212 000 cu. yd. of concrete, with over 10 000 tons of reinforcing steel, and the total estimate, as I have said, is $28 000 000; and we were given eight months in which to complete the work. I think you will probably all be interested to know that with the work substantially half completed at this time the present expectations are that the entire project will be completed and turned over for operation well within the time set, and also well within the appropriation allotted for the work. [*Applause.*]

DISCUSSION.

PRESIDENT DAVIS. It does us all good to find out what the other man is doing, for we are inclined to exaggerate our own difficulties and our own troubles. We don't appreciate how we ought to curtail our own work and limit ourselves in order that the Government's entire program may go through. When we realize the overwhelming amount of work the Government is doing in order to carry on the work on the other side, it makes us the more reconciled, I believe, to getting along with our own difficulties.

I feel quite sure that Major Gow will be willing to answer any questions you may like to ask. There is one question I should like to ask him, and that is in regard to the 125 000 tons a day. Is there any probability of that decreasing because of salvage operations which may be put into effect on the other side, or does that figure take that into account? We have heard a good deal about the salvage operations, and it seems to me that possibly there might be an initial amount of freight which might not hold in the same ratio after the salvage operations were well organized.

MAJOR GOW. Of course all these figures, Mr. Davis, are approximations, but it is my understanding that the basis of 50 lb. per day per man is what experience has shown to be the requirement. The salvage, of course, undoubtedly will affect the gross requirements; and it will also make a very decided difference whether the troops are actually engaged to a large extent or whether they are only intermittently on the firing line. But this is taken as the average requirement on which to base the capacity of the several shipping plants.

MR. J. M. DIVEN. Is the estimate of 600 ships, 21 ships sailing per day, based on 2 000 000 men?

MAJOR GOW. No; that was decided on as the ultimate capacity, about 125 000 tons, for 5 000 000 men.

EXPERIENCE IN LABOR TROUBLES.

Topical Discussion.

[September 12, 1918.]

The President. I have found that a pension system has been one of the most remarkable stabilizers of the labor force, and has served to retain a large part of an organization that would otherwise have been tempted by outside employment through higher wages and have been lost to the city water works.

We have in Philadelphia a pension system carried on by contributions, which is available to any man who has been twenty years in the employ of the city and who has reached the age of sixty years. The maximum amount of the pension is $1 200 and from that goes down to a minimum of, I think, 50 per cent. of what the man has received during the last five years of his active service with the city. I think it is no exaggeration to say that hundreds of our employees would have left us to take up outside employment at a very much higher rate of wages if it had not been for the hope of benefiting by that pension. Of course that is intimately connected with the fact that this is an old man's age at home, and the fact that the older men are less attracted, probably, by the opportunities for moving, — perhaps they do not care to go through the very arduous work and harder conditions that go with the munitions, shipbuilding work, and so forth. The pension system has proved its worth in holding and stabilizing the force at this particular time if for no other reason. You know Eve was the source of all our troubles; and while I do not like to blame it on the women, yet I have found that the women really have always been a large factor in tending to have men take outside employment, giving up a steady job for the sake of getting larger wages. I have had hundreds of men come to me and say, " My next-door neighbor is working at Cramp's," — or over at Hog Island, or at the New York Shipbuilding Company, or Baldwin's, or some place like that,— " and he is coming home with $25, $30 or $40 a week, and his wife comes in and tells my wife about it, and my wife simply can't stand it. Here I am getting perhaps, $18 or $20 a week, and my neighbor is getting double that, and, while I want to stay with the water works, and don't want to lose the job, yet the pressure is too strong at home." That is only human nature; but it is an interesting thought that really pride and vanity have had a tendency to offset things.

I heard an interesting thing in connection with the Bethlehem Steel Works, showing, perhaps, on the opposite side from what it would be in the municipal plant. In the Bethlehem they are paying tremendously high wages. A man can get all he wants to live on in three or four days' work a week, and there is no incentive to work the other days in the week. The families are satisfied, because all the people in the town are working under the same conditions, and there is no rivalry. Yet the Bethlehem executives have gone out of their way to get the employees in debt and get them to buy pianos, victrolas, and so forth, so as to compel them to work six days a week in order to pay the debt. That is a very curious thing, but it is an actual fact. I suppose all of us have found — although we do not pay the extremely high wages that the Bethlehem people pay, — yet even with the wages that are paid to-day by the water works — that a good many men will not work over five days a week, because they have enough to live on. Formerly a man had to work six days a week in order to make a living; now he can make enough in five days and doesn't have to work the sixth. That is the case with the unmarried man who has not the household inclinations.

Another instance that that brings to my mind is this: We have the vicious practice of paying for Saturday afternoons whether the man works or not. I don't know whether that prevails in most of the companies, but I believe the Saturday half holiday paid for is an exceedingly bad practice, because it tends to create a large amount of absenteeism. We try to get over that by not permitting any man to work at all on Saturday unless he has worked the five preceding days.

Mr. J. M. Diven. How is that pension fund created?

The President. By contributions. It has been running only about five years at the present time. It was started on supposedly the best statistics, and up to the present time it has been self-supporting.

MR. DIVEN. Contributions from the men?

THE PRESIDENT. Yes.

MR. DIVEN. Like contributory insurance?

THE PRESIDENT. Yes. It is compulsory with salaried employees and it is optional on the part of the per diem employees. But practically all the per diem employees have participated, and up to the present time the fund has been self-supporting.

MR. FRANK L. FULLER. That is taken out of their weekly envelope?

THE PRESIDENT. Yes.

A MEMBER. What is the minimum term of service?

THE PRESIDENT. It has been, twenty years in the city's service, and the man must reach the age of sixty years before he can participate in the pension, unless he has actually served twenty years before he is sixty years old and has been incapacitated through no fault of his own. Then, on a certificate from three doctors, he can participate in the pension fund. For instance, a man might be fifty-six years of age and have contributed or have been in the employ of the city for twenty years, and contributed the requisite number of years in the pension fund. If he happened to have an accident and was not fit for continued employment, he could be put on the pension fund, on the certificates from three physicians that he was incapacitated.

A MEMBER. What happens to the man who is discharged or who resigns before he is eligible to the pension, and who has contributed to the fund? Is his money returned to him?

THE PRESIDENT. He can withdraw. I remember we discharged one man for theft who was over sixty years of age and was eligible for the pension, but we could not prevent him from participating in the fund even though we discharged him for theft which was proven. That was one of the oversights when the Act was drawn up which I think will have to be corrected in the future.

MR. C. A. BINGHAM.* I came here more to listen, but to start discussion I would like to state some troubles we are having at the present time, and it will possibly bring out some discussion. We have a hundred employees in our various departments. They are unionized. At the present time they have been on strike three weeks. We have 30 men working in the departments, 60 men out, 10 on the fence. We pay a minimum of $3 for an eight-hour day. We have 38 men at $3, 29 at $3.25, 23 at $3.50, and the balance at $4 or more. This is for an eight-hour day, but we give Saturday afternoon with pay for five months during the summer. That Saturday afternoon spread over the year is equivalent to 3.8% additional pay. We give two weeks' vacation with full pay to any man who has worked over two hundred eighty days. That is equal to 4.2% a year. If a man has worked twenty-five years and has become incapacitated and is over sixty years of age, the city pensions him. If he has worked twenty-five years and is sixty-five years old he can receive a pension whether he is incapacitated or not; or if incapacitated from employment, after fifteen years, regardless of age. That pension comes entirely from the public funds. We have figured from the dozen pensions we now have and from other statistics that after a man has been in the service for twenty-five years the average term of his pension runs for eight years, and it equals 8.6 per cent. of his pay during the twenty-five years. That is a total of 16.6 per cent. which the city gives the city employee over the private plant in giving those privileges. In other words, it is exactly one sixth, so that a man who is receiving $3 from the city gets the equivalent of $3.50 in a private plant. In addition to that, the work is continuous, winter and summer, for these permanent men.

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* City Manager, Waltham, Mass.

They have now gone out on strike, and their contention is that the minimum shall be $3.25, and all the men now graded as skilled laborers, mechanics and so forth, shall receive also 25 cents additional. That means $25 a day, or $7 500 a year, which we have not included in our budget.

During the three weeks we have found out some very interesting things. In the Street Department, ash and refuse division. they used to have two or three trucks cleaning up the city, but for the last two weeks have only had one truck doing exactly the same work that two or three trucks did before. On the present truck we have a foreman, mechanics, and blacksmiths, working for from $4 to $6 a day; but of course that one truck does not equal the cost of three trucks formerly, and we are getting more per dollar in work out of one truck than we did out of three. The same occurs in the other departments.

The bad part comes here: We can take back 30 of the 60, and, of course, will take the best men, the $3.25 or the $3.50 men, and the older men nearing the pensions; but when we refuse to take back the $3 men they will all say they have been discriminated against because they were instrumental in the strike and in the operation of the Union. That is true. The $3 men are the men who have been in the department a very few months, and they are the ones who started the labor agitation and have convinced the older men that they belong to a secret organization and should strike for the benefit of the other men. But the old men are holding the strike for the reason that the older men cannot go out and get other jobs like the newcomers who are going into munition plants and so forth, and making big money. We are having conferences every day, and personally I don't know how the matter will work out. But I thought possibly the information might lead to some discussion which would help us all eventually.

Mr. H. V. Macksey. In the city of Woburn, which almost adjoins Waltham, we have similar conditions. In the summer we have 100 to 125 men on the pay-roll, but during the winter, when there is practically no work being done, we have 20 or 25. We have within the last three years increased the minimum wage from $2 to $3. We have practically the same conditions that

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Note. On September 14 the above strike was settled by the execution of an agreement drawn up by the Chamber of Commerce Arbitration Committee and submitted to both sides.

Clause 1. Minimum to be raised to $3.25.

Clause 2. Agreement to hold no more strikes during the war.

Clause 3. All employees now receiving $3.25 or more are not to request any increase.

Clause 4. No back dating on the increase of clause 1.

Clause 5. Striking employees to be re-engaged only as work and funds permit.

Clause 6. All future differences to be settled by the city manager, arbitrator of City Employees' Union, and a third mutually selected member.

they have in Waltham in regard to holidays. We pay for legal holidays; we pay for Saturday afternoons four months during the summer, and we give two weeks' vacation with pay to every man who has worked two hundred days during the year.

Three years ago a union was established in Woburn, to which I had no objection. I believe that the workingman is justified in having a union, and that if a union is controlled and guided by intelligent, honest men it will do no damage to the workingman or to his employer. Unfortunately, the average laborers who constitute a union are uneducated, and they are led by the man with the fluent tongue. He is not always the most intelligent, nor is he always the most honest member. In Woburn, we have now reached a point where we have trouble, not a strike, but our men have abandoned us, because we will not give them a minimum wage of $3.50. It is my opinion that it is partly bad management on our part which has caused this condition. Any man who understood laboring men and labor conditions should have known that during 1918 we could not hope in this part of the country to hold ordinary good labor at less than $3 a day. Our laborers very early in the year asked for $3, and our mayor refused to approve the rate. The men were forced to threaten strike, and then they got the three dollars. During that time the strike bug got into their systems, and some of them were disappointed because there was no strike. As soon as possible they seized upon another matter, in order to go before the mayor, and incidentally they demanded $3.50, which demand he refused. Knowing the prevailing rate of wages, and knowing the conditions under which the workingmen live, I advised that the proper thing to do was to give them $3.50, because we have a certain amount of work which we want done at this time, and we have money enough to pay for it. Our money will not pay for as much work for us as we had hoped to do, but the non-essential work could be postponed.

I look upon the municipal employee as a different man from the man who is employed by a private concern. The men who work under me have lived many years in Woburn; I have been there but few. They will probably live there all their lives; — I sincerely hope that I shall not be buried in Woburn. When talking with them, one must remember that he is talking with his neighbors, that he is talking with his friends, that he is talking with men who are as deeply interested in the success of the municipal enterprise and in the improvement of their city as he is. One must remember that in the municipal corporation each one of them has the voting power of one share of stock, — no more and no less. All these things are to be considered.

I am far from being a politician, — I was not built on that line, and could not be one if I tried; and yet I believe that any employee of a city, county, town, state, or of the Federal Government, who blinds himself to the fact that politics is one great factor in his job, is foolish. We should recognize politics; we should do business with the politician on a friendly basis as long as he is square and as long as he is on the level. I believe that true politics, proper politics as a man in my position should play it, is what the people of the city, the people who hire me and who pay me, wish me to play.

If we took a popular vote in our city to-day, the great majority of the people — not only the working people but the merchants who have the workingman's trade, the landlord who collects the rent from him, and even the manufacturers who own the tanneries and the chemical works in Woburn — would say, " Sure, you must pay that rate; you might as well pay it; they are the men you have had for years, and they are the men you are to have in years to come, and you cannot import labor to fill their places; make the best terms you can with them to-day, give them a living wage." Very few men to-day who are earning $18 to $25 a week are buying baby grands, victrolas, or tin Lizzies; they are satisfied if there is corned beef and cabbage on the table on the days that the Food Administration says that beef may be eaten. We should not be carried away by the idea that they are merely wage earners, and take the capitalistic view that it is our sole business to get as much out of them as we can. We should consider them as men; as a matter of business, it pays to do so. Almost every big manufacturer will agree that he should have a welfare department. We all should consider the fact that a satisfied workingman is an asset to any employer, and a dissatisfied workingman is a liability. My men working at $3.50 are worth much more than they would be if forced to accept $3.25 or $3. You cannot hold a man's nose to the grindstone all the time. You can say, " There is your job," and put him on it, and if he does a good day's work, and is energetic and willing, you get a satisfactory result and you are pleased. If he is an absolute loafer or mutineer, you discharge him; but if he just soldiers along and does a fair day's work, but takes no interest, you get a poor job, an expensive job, but you can't discharge the man.

When you come to consider what you should do, you must recognize the fundamental union principle, " All for one, and one for all." That principle should be accepted by the employer as well as the employee. When we place the minimum rate at $3.50, we know full well that we will have a certain number of men who are not worth $3.50, and we will have a certain other number of men who are worth, perhaps, $4.50. But the strong must carry the weak, and the young men must carry the old; that is their part of the contract, as well as ours. If, in all municipal employments, we try to classify laborers as to age and as to physical ability, not only will we be in trouble all the time, arguing with the men that this man should not go up, and that that man should come down, but we will feel uncomfortable when we look into the face of the old workingman, who has been in the service many years, and spent the best part of his life on the job, and say to him, " Mike, I am sorry, but I must cut a quarter off your rate to-day; you are not much good now." The citizens who are paying the bills do not want us to do that. It is not good business. There is such a thing as being fair, — coldly fair, absolutely just, — and you can deal in that way with machinery; give it the right amount of oil and the right amount of power, stop it when you like, start it when you like, and it goes. Feed a dog, and he will always keep at your heel and call you master; but a man will not act that way. Let us not forget that we are dealing with men; let us not forget that there is a condition in this world to-day such as no man living ever saw, and that probably no man living will ever see its like again. The workingman to-day has his chance to fight for wages and win, and if he goes too far and is unreasonable he will pay the penalty later. When this war is over and all our men come back, conditions will be recast, and the common laboring man will unfortunately be forced again to take off his hat and say to the wealthy man, "Please let me earn a dollar." I think we make a mistake if now we fight too hard for low-priced labor. We make the mistake, if our men walk away from us to get employment elsewhere, if we think they are influenced by German propaganda. They are not. They are influenced by the fact that their neighbors go out and do better, and they cannot understand why they should sit idly by and suffer. When it is all over they will not be praised for staying on the job. If your child is dressed better than my child to-day, you and I will say, "Oh, that is a mere trifle"; but the mothers do not think it a trifle, and you can't make them think that it is. But if your child and my child are not well fed to-day, you and I demand a change, — and demand it now, — and you say, "I am going to feed my child as well as any other man feeds his; I am going to clothe him as well as any other man clothes his; I am going to educate him as well as any other man educates his." It is that ambition in the American citizen that has made the American citizen what he is, — that has given him more courage for fighting and more ability to fight than any other man in the field.

We can't win the war nor make this a great country by singing the "Star-Spangled Banner" at nine o'clock on any given evening. We can only win this war, or any other war, by treating men as men all the time. Do not be carried away by the fact that dollars and appropriations are the things we are dealing in. If we can't handle the man who is over us, as well as the men who work under us, we are failing in our jobs. I realize that I am just now among the failures. I have put myself in that class, because I am not able to handle the man who is over me. I am forced to be helpless, without men, to-day — because I have not got head enough, I have not the ability, to convince the man who is to-day mayor of the city that he should change his attitude, and let us put our city in proper, peaceful working order.

Mr. Agnew.* I have a very small system and very few men, but unfortunately the Government built a plant in my town and robbed me of all my men, unless I paid about double the wages I had been in the habit of paying. Mr. Moore spoke on the subject of raising rates. My works is one of those where we had to raise the rates. Where we used to pay the ordinary workingman $2.50 a day, we are now paying $4 and $4.25 for ordinary labor. We have to do it. They did not ask us for it, but we raised our wages to compare with the wages which were being paid on the Government cantonment. We have had no trouble, but submitted to the inevitable and gracefully paid the wages before our men left.

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* Superintendent Water Works, Scituate, Mass.

MR. J. M. DIVEN.* Most municipal plants work on a budget system, and with rapidly changing prices, both for material and labor, it keeps one in a constant worry to keep within budget appropriations made more than a year in advance. It has been possible to take care of the labor advances by cutting down the force in the speaker's case, and cutting out all work not absolutely necessary. Good laborers have been able, however, to secure much higher wages than the city could afford to pay, both on government work and from contractors doing state and other work on the cost plus system, where their costs were not limited by fixed appropriations. This has made it hard to keep first-class laborers, though some of the men realized that with the city they had a permanent job, year in and year out, rain or shine, and that the other positions would be more or less temporary, so they have stayed on at considerably less pay than they could have secured in other positions.

MR. A. E. MARTIN.† I want to heartily endorse every word of our friend, Mr. Macksey — every word. At the same time, here is a little condition which makes you feel a little bit as though human nature were on the opposite side once in a while. Our men walked out, — practically every man with the exception, perhaps, of three or four who were stand-bys and who had been with us for years and could not walk out — they were getting fairly good pay. We had four men left on the job where we were laying 10-in. and 8-in. water pipe, tying in side streets as we went along. And the men left. They gave us no reason, but the next morning, we heard indirectly, would come back to us for $3.50 a day. The board would not listen to it, and said it could not do anything without consulting the other departments of the city. I was on the point of going on a vacation, and asked, "Shall I go or stay? Do you want to handle this yourselves, or shall I stay and help handle it?" They answered, "Go ahead." I went away and came back two weeks later; found the work at a standstill and the newspapers were slamming the Water Department. This was a new street and nobody could get in ahead of us. I went to the board the next morning and asked what they were going to do. They then voted to raise the wages to $3.50, or $3.52 — we were paying $3.28 in Springfield, and we voted to give the men $3.52, 24 cents a day more. We sent word to the men that we were ready to give them this and word came back the next morning, "We will come back to work for $4 a day; we must not lose our vacation" — which they had of course lost by leaving; "we must have a rest period of fifteen minutes twice a day, and we must have full time, wet or dry." I wonder how Mr. Macksey feels about that.

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* Superintendent Water Works, Troy, N. Y.

† Superintendent Water Works, Springfield, Mass.

Mr. Macksey. Not language which could be put in public print.

Mr. Martin. Well, the men did not come back, because I had no authority to give them any more money. So we hired a contractor to come in with a few men — 12 or 15 — to help us out. We had men enough to do our pipe laying but we couldn't do the digging too. So these men came in with a foreman, who, as I heard somebody remark, might have been of some use once, but his day of usefulness had gone by. He sat on the job and saw the men attempt to work. No, I won't say that they *attempted* to work — played at work. And, out of 10 or 15 men, perhaps one third of them would work while the rest were leaning on their shovels and looking at the job. We paid the contractor $3.50 a day and paid him a 15 per cent. bonus, which made the rate of wages $4.02 for those men, and we finally got the job finished and got out of it. And I thank my lucky stars it was finished before this meeting occurred, so that I could come down to it. But that little incident of human nature (I call it pure cussedness) got me going, and I haven't recovered yet. Those fellows would have come back the next day for $3.50, but after loafing two weeks intended to make up the loss of $4.00.

Mr. Frank J. Gifford. We have not heard from Mr. Gear. He informs me that word has just come from Holyoke that a strike has been called in his department since he left.

The President. What are you going to do?

Mr. Patrick Gear. Settle.

The President. Pay them what they want?

Mr. Gear. Sure. I received the Springfield *Republican* this morning, saying that a strike had been called since I left. I will settle that to-morrow morning when I get home.

I have been interested in all the papers I have heard since I came to this meeting. The train I am going on is the 5.52, and if I get started talking I might miss it, and you might all say, before I got through, what the lady said when she was at Nantasket Beach and had been in the water. As she was coming out she said, " I am so glad I am near my clothes." [*Laughter.*]

The labor troubles in Holyoke are just the same as everywhere else. I have quite a force of men working with me, and we get along very nicely. The old fellows did not strike. It is a new gang of laborers that has made the trouble. The other men would not let go, no matter what they would ask.

With all the papers that were read here, any superintendent could stand up on the floor and take a half hour at least to express his feelings on what he had heard. I am glad that the Sedgwick paper is to be printed and sent to us, and I will have one of our Holyoke papers print it. It was the best I have ever heard. There is not any question, of course, that we will win this war. We have got the biggest man in the world to-day in this country — everybody listens when he speaks; and, as a darky boy down South said to his chum — he was in uniform and the chum was not, and the chum said, " I don't want to go " — the boy in uniform said, " You haven't got no chance for escape; if President Wilson wants you he will get you; a man that can take an hour of daylight away from Almighty God and give it to the people, and a man who can take the railroads away from the men that owned them and give them to his son-in-law — what chance have you to get away? " [*Laughter.*] I would like to know what chance the Kaiser has to get away from that kind of a man. The American boys have the world with them.

There is no question that we have to give laborers to-day what they ask if we want them. Some people may think that they are unreasonable; but when you see what we have to pay for our dinner here in Boston, and our supper, and when we go home and think that we have as nice a meal at home from our wife, that is just as good as that, and how does she do it on the small pay we give her — when you take these things into account, the laboring man does not seem so unreasonable. It is not any use for municipal corporations to think that they can hire men for the same as they did two years ago. The only thing that is keeping the men, as the last speaker said, is that there is a pension going to them when they are old, and when the war is over things might be a little better than they are now, and the work would not be so plentiful in the outside factories. There are lots of people who will disagree with us there; they think there has got to be good business in the coming years. They think we will have to build up the foreign countries; and if we do, we might as well make up our minds that we will have to meet a continued labor shortage for some years to come.

JAMES BURNIE.

James Burnie, superintendent of the Biddeford and Saco Water Company, and one of the best known and most active members of the New England Water Works Association, passed away at his home in Biddeford, on November 27. The cause of his death was anemia, which had been in evidence for some time, but had not become serious until the early part of last summer, at which time his condition became so serious as to compel him to abandon the active conduct of his office. Until then, he had attended regularly to his business, but in July turned over the management of the company's business to his son, assistant superintendent Arthur N. Burnie.

The passing of James Burnie is a great loss to Biddeford, where he had for years been one of the most prominent figures, being very public spirited, and taking an active interest in all matters pertaining to the welfare of the city.

He was a generous but unostentatious giver to charity.

James Burnie possessed one of the strongest and most admirable characters of his day; honest in the highest sense, and with an intense dislike for sham.

He was a great lover and strong believer in American institutions, and a thorough patriot.

James Burnie was of Scotch descent, being born in Stranraer, Scotland, June 17, 1842, and was a son of James and Jannette Burnie.

He came to Ridgeway, Canada, with his parents, while a boy, where he remained until the outbreak of the Civil War, when he enlisted in Detroit as a private in the 17th Regiment of Regulars, serving until the close of the war, and was discharged with one of the most honorable records of his regiment. He took part in many prominent engagements, among which were Chancellorsville and Gettysburg, being severely wounded at Gettysburg, and for three or four days lay on the ground without care, helpless.

Upon being discharged from the service, he located in Portland, where he learned the trade of a machinist, after which he served as marine engineer on coastwise steamers. From this time, he was connected with testing steam-driven vessels.

He then entered the employ of the Portland Water Company, under the late George P. Westcott, and was active in the reconstruction, placing upon a substantial basis the Sebago Lake supply of the Portland Company.

In 1884, he went to Biddeford as superintendent of the Biddeford and Saco Water Company, the plant being then in the process of construction, and covering but a small territory. At the present time the company has a total of forty-five hundred subscribers and covers Saco, Old Orchard, Pine Point, and along the coast, the plant having reached a high state of development under the efficient management of Mr. Burnie.

Mr. Burnie was interested in several fraternal organizations, being a member of the Ancient Landmark Lodge and Mount Vernon Chapter, Royal Arch, A. F. and A. M., of Portland; and Bradford Commandery, K. T., of Biddeford. He was a 32d degree Mason, holding membership in a Scottish rites body in Portland. He was a member of one of the Portland lodges of Odd Fellows, of Mavoshem Lodge, K. P., of Biddeford, and the 17th Regiment Association.

Mr. Burnie was one of the most companionable of men, and made friends with whomever he came in contact.

He was twice married, and is survived by a widow and three children: James W. Burnie, of Plattsmouth, Neb.; Miss Helen M. Burnie, of Biddeford, by his first marriage; and Arthur N. Burnie, superintendent of the Biddeford and Saco Water Company, by his second marriage.

Mr. Burnie became a member of the New England Water Works Association June 11, 1890, and has been one of its most active and popular members. He was Vice-President in 1901, 1902, 1905, and 1915.

The Association, in common with his home city and state, experiences a great loss with the passing away of Mr. Burnie, which will be felt by all, both old and young, who have had the pleasure of his acquaintance.

PROCEEDINGS.

NOVEMBER MEETING.

HOTEL BRUNSWICK,
BOSTON, November 14, 1918.

Vice-President Samuel E. Killam presiding.

The following members and guests were present:

HONORARY MEMBERS.

E. C. Brooks.
R. C. P. Coggeshall.
Desmond FitzGerald.
R. J. Thomas. — 4.

MEMBERS.

L. M. Bancroft.
G. W. Batchelder.
A. E. Blackmer.
G. A. Carpenter.
F. L. Cole.
John Cullen.
A. O. Doane.
John Doyle.
L. R. Dunn.
E. D. Eldredge.
F. L. Fuller.
Patrick Gear.
H. T. Gidley.
F. J. Gifford.
J. A. Gould.
R. A. Hale.
A. R. Hathaway.
J. L. Howard.
W. F. Howland.
J. A. Hoy.
Willard Kent.
S. E. Killam.
G. A. King.
P. J. Lucey.
H. V. Macksey.
A. E. Martin.
H. A. Miller.
M. L. Miller.
H. E. Perry.
L. C. Robinson.
G. A. Sampson.
P. R. Sanders.
C. M. Saville.
A. L. Sawyer.
D. N. Tower.
F. B. Wilkins.
I. S. Wood.
M. B. Wright. — 38.

ASSOCIATES.

Bond, Harold L., Co., F. M. Bates.
Builders Iron Foundry, A. B. Coulters.
Byers, A. M., Co., H. F. Fiske.
Edison Mfg. Co., H. L. B. Watson.
Hayes Pump Machinery Co., F. H. Hayes.
Hersey Mfg. Co., W. A. Hersey.
Lead Lined Iron Pipe Co., T. E. Dwyer.
Ludlow Valve Mfg. Co., A. R. Taylor.
Mueller, H., Mfg. Co., C. J. G. Haas.
National Meter Co., J. G. Lufkin and H. L. Weston.
Neptune Meter Co., H. H. Kinsey.
Rensselaer Valve Co., C. L. Brown.
A. P. Smith Mfg. Co., F. L. Northrop.
Thomson Meter Company, E. M. Shedd.
Union Water Meter Co., D. K. Otis and H. W. Jacobs.

ASSOCIATES — *Continued.*

United Brass Mfg. Co., G. A. Caldwell.

Warren Foundry & Machine Co., J. H. Morrison.

Water Works Equipment Co., W. H. Van Winkle.

Worthington Pump & Machinery Corp., Samuel Harrison. — 21.

GUESTS.

MASSACHUSETTS.

East Pepperell, Lewis D. Bemis.

Worcester, Robert F. Batchelder.

RHODE ISLAND.

Bristol, J. M. Jones.

PENNSYLVANIA.

Pittsburgh, George F. Maglott. — 4.

The Secretary read the following names of applicants for membership, approved and recommended by the Executive Committee:

Clarence W. Mills, Woonsocket, R. I., superintendent Woonsocket Water Department; Harold S. Noyes, Newburyport, Mass., secretary and treasurer, Water Commissioners; John P. Young, Worcester, Mass., foreman Water Department; Henry T. Wheelock, Lynn, Mass., foreman Lynn Water Department.

On motion of Mr. Macksey, the Secretary was authorized to cast one ballot in favor of the applicants, and he having so voted they were declared duly elected members of the Association.

VICE-PRESIDENT KILLAM. I want to take this opportunity of calling upon one of our esteemed past presidents, a member of the Engineers of National Defense, who has recently taken a trip to the New York water supply. We realize that many things have taken place in the last few days. We know what we have passed through, and little did we think at our September meeting that changes would happen so rapidly as they have. Only time can tell just what will happen in the future, but we will look on the bright side and hope that everything will be for the best, and that our boys who have gone across will soon be back on their native soil, where they will be doubly welcome. I now take pleasure in calling upon Desmond FitzGerald. [*Applause.*]

REMARKS BY MR. DESMOND FITZGERALD.

MR. FITZGERALD. It is always a pleasure and a privilege to talk to this Association, and as I look around and see so many familiar faces I am quite assured that you will pardon any imperfections in this little talk I am to give you, which must be extemporaneous and with very few minutes' notice. I don't know that it will interest you, but I know mighty well that I was interested as perhaps I had not been for a long time before in a little trip I took last June with Mr. Stearns over the sources of the New York water supply, the new Catskill supply; and when I was asked if I wouldn't say a word here this afternoon, I thought perhaps that might interest you.

You all know that the New York supply is the biggest in the world in many respects, — the largest in the country, certainly, and almost the longest in extent of works, although the Los Angeles works, I fancy, is somewhat longer. Mr. Stearns and I left here on the eight o'clock train in the morning and changed cars at Chatham — I speak of this because it is a mighty good way to go if any of you ever wish to go; we changed cars at Chatham and then at Hudson, and then we crossed the Hudson River and landed at Kingston Point and got up to the hotel in time for supper that night.

Kingston is right at the foot of the mountains, and there at once you are surrounded with the beautiful purple mists and masses of the mountains. Kingston itself is quite an interesting place. It was the seat of the old New York senate. We passed our leisure time in examining the town and going into the cemetery, seeing some of the old graves, and going into the old senate house. It did seem very interesting to go into that little bit of a house, not much larger than a gate-house, which was the original senate chamber of what is now the great Empire State of New York.

In the meantime Mr. Waldo Smith, the chief engineer of the works, was on his way from New York, and reached Kingston that evening. The next morning early we took his car, a small Franklin, and he was the chauffeur, — and a good one, too, — and went around the Ashokan Reservoirs. They are extremely interesting. Of course we have in Massachusetts some of the finest reservoirs in the world, but these at Ashokan were interesting because they were not entirely of the same type, and we always have the varieties and variations. There are two principal reservoirs, and around those reservoirs I think is about the finest road I ever saw for a water supply. It wasn't wide but it was very smooth, as smooth as a floor; and we had no trouble in going at the rate of thirty-five miles an hour. That was thought to be slow, but I don't care to go very rapidly myself, — I like to see things; so, out of consideration for an old man, they reduced the speed to thirty-five miles an hour.

We went around the reservoirs and saw the beautiful situation there at the foot of the Catskill Mountains, and then came to the gate-house. Before going into the gate-house we went up on to an eminence and climbed a tower by one of these circular iron stairways, and the views from there were most beautiful. Then we came down to the gate-houses. The gate-houses are very remarkable. I don't think I have ever seen gate-houses anywhere in the world on such a large scale, with such enormous gates, and with so much machinery so well adapted to handle every part of them. There is a laboratory there, but you know we have laboratories on our own works so there was perhaps nothing very remarkable about that to a Boston engineer. The interesting specialty there was the wonderful fountain. I don't expect ever to see another fountain anywhere in the world like it. Really it makes you stand aghast to see the whole water supply of the city of New York coming out through little two-inch nozzles and carried up into the air perhaps thirty or forty feet in jets which are close together and yet you can identify them. The water was so white that these jets were like a tablecloth, perfectly white, and you can imagine that it is a beautiful sight. The water which is stored in reservoirs where the bottoms have not been properly prepared, under our old Boston system, as a rule gives out a good deal of sulphureted hydrogen for the first few years, and I have a number of times stood at the outlets when they were drawing the water when it was very disagreeable indeed to stay there. If there should have been some organic matter left, which I think there was, — I don't think the preparation of the bottom of the reservoirs for the New York supply was done in the same way in which our Boston reservoirs have been treated, — the idea of this aëration was, of course, to get rid of any gases which might be in the water when they were drawing it from the bottom. But I did not detect any odor, and the water was perfectly white. The water which comes out from the bottom of a large and deep reservoir which has not been well prepared is very apt to be partly discolored and to contain foul gases, but I didn't notice any there.

Then we got into another terrible machine. If the first one was a brute, this was a monster. It was an eight-passenger car, and I said to myself, This means forty or forty-five miles an hour; and it did. But they kept the speed down to thirty-five miles an hour out of regard for me, I think, most of the way, but we did go occasionally forty-two miles an hour; I know, because I saw the indicator. But I made up my mind to enjoy it; that if I was going to be smashed up I might just as well have a good time as be all the time wondering what was going to happen. [*Laughter.*] And we did have a good time. We went the full length of the aqueduct. We made the crossing of the Hudson at Newburg, and there we saw the very beautiful gate-house. I don't think I have ever seen a gate-house anywhere in the world like it. I have seen larger ones, but those at the Ashokan Reservoirs are very artistic gate-houses on a very large scale and built of stone, — I think some parts, as I remember, were artificial stone; but this gate-house on the Hudson, which receives the tunnel after passing down under the river — and you know that is quite a remarkable crossing and I will say a word as to it later — is one of the most beautiful and artistic buildings I have ever seen. It stands there fronting the Hudson River.

Inside of the gate-house — well, I kept out because I didn't want to be asked to go down one thousand feet; but there was a machine which was suspended in the air and which some men did go down in for one thousand feet. I didn't care to go, and we didn't have time even if we had had the inclination. This crossing of the Hudson — you look at the river and, we will say, it is a mile wide, — I don't know exactly how wide it is at that point, — and say it is thirty or forty feet deep. Then you have the silt and the clay and the sand and the gravel which filled up the old bed of the river which was made by the glaciers. When they undertook to make the borings from the surface of the river they couldn't get satisfactory results, so they had to sink shafts on each side of the river and then run hand-drill borings through the rock. The thing was, of course, to find out how deep this old bed was. It was many hundreds of feet deep, carved out by the old glaciers and filled up with glacial débris. I don't recall the exact depth they had to go, but it was something like eight or nine hundred feet, I think, below the river, in order to get into good, solid rock.

Then following down the Hudson we came to the terminal, or equalizing reservoir. That is a perfectly superb structure. The dam there I think is one of the most remarkable I have ever seen, — the Kensico Dam. There has been a greater effort to produce an artistic effect than even at the Ashokan Reservoirs, and it looks to me as if the architect had had an unlimited order. I never have seen anywhere in the world more elaborate — well, I won't call them " elaborate " because they are sufficiently simple, but extensive — decorations. As you stand on the Kensico Dam and look down the stream, I should think, for a distance of half a mile, you see an open, level space in which there is a very extensive fountain arrangement and grounds; and the dam itself is flanked by structures which are built, I think, so as to add to its dignity. That reservoir in itself, although it is a compensating reservoir for the aqueduct, would be a very large storage reservoir anywhere in the world.

Then we went on down to the terminal reservoir, where the pipes extend into tunnels and pass under the East River to New York; and the rest of the system then is by an enormous tunnel, as you know, through the bed rock under the city of New York and feeding the different parts of the city from that as from a main, and then over to Brooklyn and Staten Island.

We had allowed one day for this visit, and they had guaranteed to deposit us at the Grand Central Station by six o'clock, and they did. But in order to do it we had to go through the streets of New York at a rate of speed, — well, I won't attempt to say what it was, but my heart was in my mouth every moment. [*Laughter.*] I don't know that I have given you much idea of our trip, but if you have enjoyed the talk as much as I have, or a tenth part as much as I enjoyed the trip, I shall be more than satisfied. Thank you very much. [*Applause.*]

VICE-PRESIDENT KILLAM. As you all know, Mr. FitzGerald is one of the fathers of our Boston additional supply. Some twenty years ago, when I first became connected with the Metropolitan Works, one of the first books I picked up on entering the engineering force was a small book in the front of which Mr. FitzGerald had written, " A dangerous book for young engineers to use." [*Laughter.*] I was telling him to-day that I had never used that book. At another time, when I was relieving Mr. Sherman, who was Mr. FitzGerald's assistant at that time, I recall one afternoon while I was figuring out some measurements Mr. FitzGerald arose suddenly and came over to where I was and said, " Say, young man, what are you doing? " I said, " I am figuring " — I didn't know what he was going to do to me. He said, " Why don't you make a noise? " [*Laughter.*] It was so still in the room I think he supposed I wasn't there.

When I was first connected with the works the engineer under whom I was employed was a man who had for his motto, " Do it now." At that time he was doing it, and he has been doing it ever since. He is a hard-working engineer, always thinking out something new, and it was a great pleasure to be associated with him in connection with the Metropolitan Works. I learned a great deal from him at that time, and he has been very good to me ever since in forwarding information of various kinds. He has prepared, and after a good deal of work I have finally succeeded in getting him to present, a paper to this Association, which he will now read to you. I refer to Caleb Mills Saville, of Hartford, Conn. [*Applause.*]

Mr. Caleb M. Saville, chief engineer, Board of Water Commissioners, Hartford, Conn., then read a paper entitled, " Rates of Flow in Service Pipes and Meters." Mr. Lewis R. Dunn, superintendent of the Winthrop Water Department, told of the successful use of water meters in Winthrop.

The subject for topical discussion was, " Experience in Labor Troubles." No one desiring to say anything on the subject, the meeting adjourned.

EXECUTIVE COMMITTEE

Meeting of the Executive Committee of the New England Water Works Association at headquarters, Tremont Temple, Boston, Mass., Wednesday, November 13, 1918, at eleven o'clock A.M.

Present: Samuel E. Killam, Henry V. Macksey, Percy R. Sanders, Frank J. Gifford, Lewis M. Bancroft, and Willard Kent.

Four applications for membership were received and unanimously recommended therefor, viz.: Harold S. Noyes, secretary and treasurer Water Commissioners, Newburyport, Mass.; Henry T. Wheelock, foreman, Lynn Water Department, Lynn, Mass.; Clarence W. Mills, superintendent Water Works, Woonsocket, R. I. and John P. Young, foreman, Water Department, Worcester, Mass.

The Secretary was instructed to communicate with associate members in regard to listing their representatives at the meetings of the Association.

Adjourned.

Attest, WILLARD KENT, *Secretary.*

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715 Tremont Temple, Boston, Mass.

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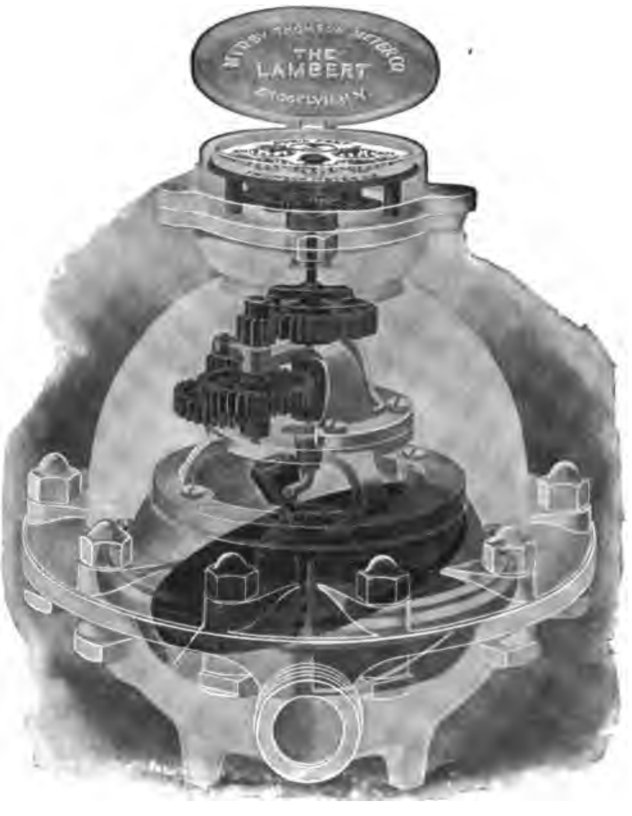
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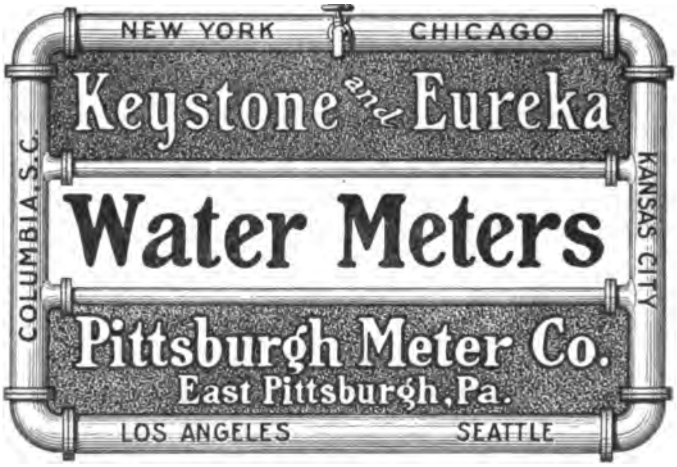

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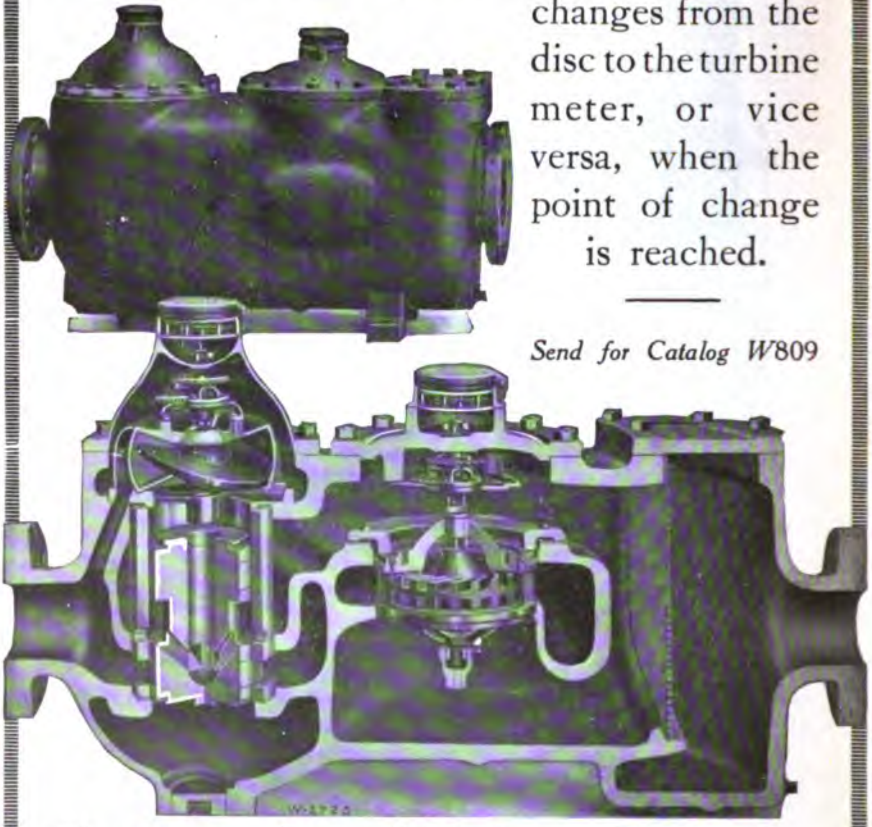

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A MEMBER OF THE

New England Water Works Association

PAID FOR A

Union Compounding Valve

IN 7 WEEKS

THROUGH INCREASED REVENUE

GENTLEMEN: June 4, 1918.

In reply to your request for figures on test of 4-inch Union Compounding Valve installed at the plant of the . . . . . . in this city, we submit the result as stated below:

Apr. 15, '18. 4 in. Current meter read	9,255,000	cu. ft.
May 15, '18. 4 in. " " "	9,788,700	" "
	533,700	" "
1-in. King by-pass meter read	132,600	" "
Total . . .	666,300	" "
Average consumption on 2 prior months	572,600	" "
Actual increased registration	93,700	" "

The increased registration at our rates netted us for one month the sum of $74.96 and the cost of the valve being $121.50.

As a result of this test we have purchased the valve installed and have also ordered another.

Yours respectfully,

(. . . . . .) Supt. Water Works

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INCORPORATED 1868

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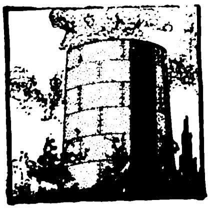

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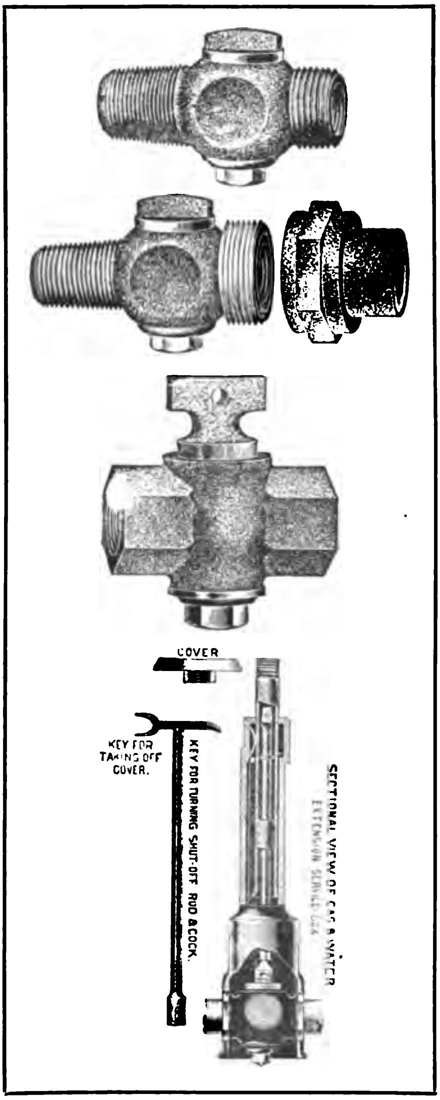
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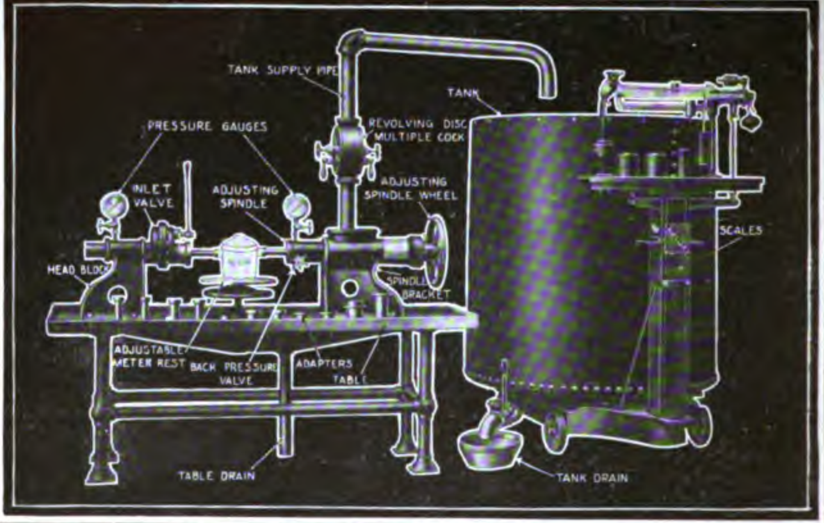

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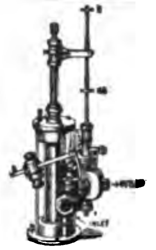

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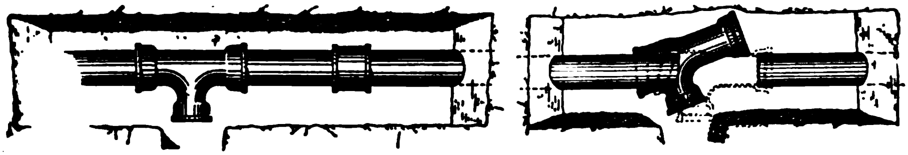

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ANTI-FRICTION
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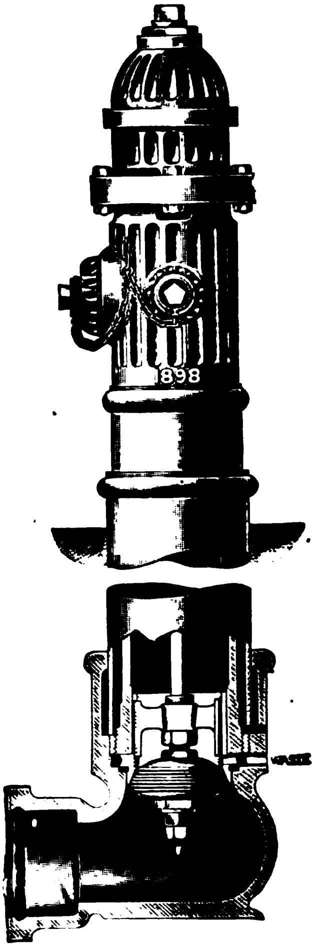

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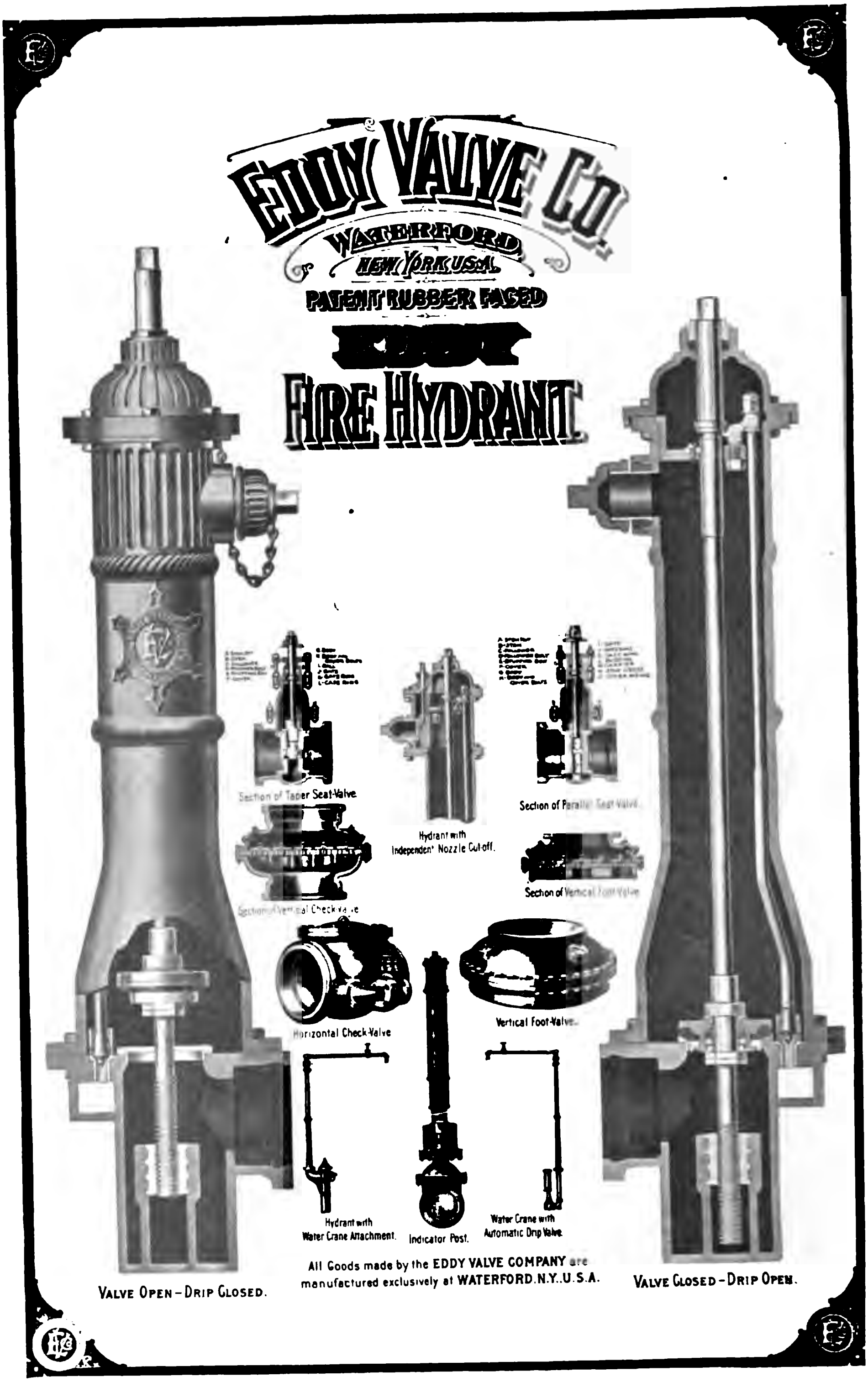

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Thirty thousand feet — 2,500 bell and spigot joints — of U. S. Cast-Iron Pipe — laid over rough country — granite bowlders — sharp dips of from 12 to 20 feet under water — and all without a special casting or a bend of any kind.

Such is the latest story of Cast-Iron Pipe efficiency — and the efficiency of the good, old-fashioned bell-and-spigot joint.

There were 2,500 joints, and out of all that multitude only three showed slight signs of leakage when the line was tested.

At one point the line dipped through a lake, dropped 20 feet under water, then rose to the shore on the other side. The lake was narrow, — we'll show you a picture of that later, — so you can imagine the tremendous strain to which those joints were subjected. With that in mind just recall that only three joints out of 2,500 showed even a slight leak. Some 2,497 joints perfect, in spite of the rocky-road-to-Dublin conditions almost everywhere.

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(Every Atom Pure Lead)

For calking pipe joints under the most difficult conditions.

For overhead joints, or in wet places where the use of molten lead is not only impracticable, but dangerous — **LEAD WOOL** may be employed to advantage. It makes perfectly tight joints to withstand the highest pressures, yet sufficiently elastic to admit of considerable sagging or settling of the pipe without causing the joint to leak. The difference in this respect, as compared with the poured joint, is notable.

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***Highest quality* Lead Lined Iron Pipe and Fittings**

***Also* Pure Block-Tin Lined Iron Pipe and Fittings**

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YOU SHOULD USE

Trade "LEADITE" Mark

Registered U. S. Patent Office

FOR

Jointing Water Mains

1. **DURABILITY.** Leadite joints increase in strength with age.
2. **NO CAULKING.** Leadite joints require no caulking, because the Leadite adheres to the pipe, making a water-tight bond.
3. **COMPARATIVE QUANTITIES.** One ton of Leadite is equivalent to four tons of lead.
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11. **DAMAGE SUITS.** Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.
12. **USERS.** Progressive water works all over the country use Leadite.

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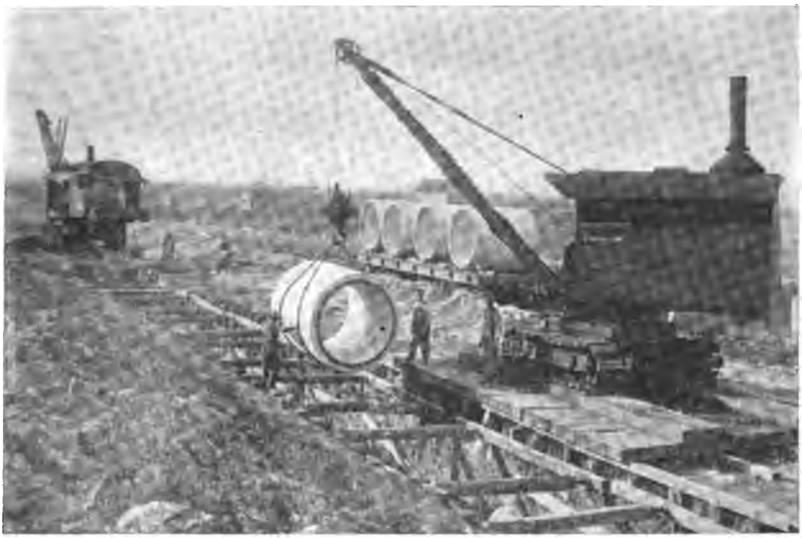

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Length, 10 miles.

Heads, 45 to 90 feet.

All Pressure Pipes are provided with Copper Expansion Joints.

The Strongest and Most Permanent Water Pipe made.

We will gladly furnish you with estimates.

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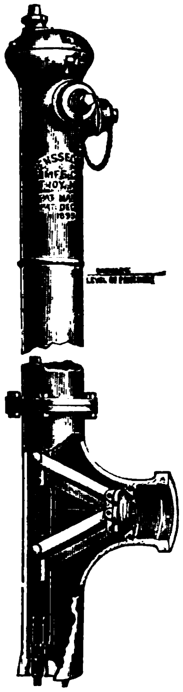

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Send for it.

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New England Water Works Association,

ORGANIZED JUNE 12, 1882.

APPLICATION FOR MEMBERSHIP.

I, the undersigned, residing at..

.... *being desirous of admission into the New England Water Works Association, hereby make application for* ....
(*resident, non-resident or associate*)
....*membership.*

I am..*years of age, and I have been engaged in the following named work:*

....

....

....

I will conform to the requirements of membership if elected.

Signed,..

Address,..

Dated,..*191*

Resident members are those residing in New England; all others are non-resident.
Entrance fee is $5.00 for resident and $3.00 for non-resident members.
Annual dues are $4.00 for both resident and non-resident members.

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The Journal of the New England Water Works Association

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